MARITIME Series

MONOGRAPHS

Yves Bourgeois
Samuel LeBlanc

Innovation in Atlantic Canada

INSTITUT CANADIEN DE RECHERCHE SUR LE DÉVELOPPEMENT RÉGIONAL
THE CANADIAN INSTITUTE FOR RESEARCH ON REGIONAL DEVELOPMENT

The Canadian Institute for Research on Regional Development, located on the campus of the Université de Moncton, was established in 1983. It is an independent, nonprofit organization governed by a board of directors. Through its research, publication and conference programs, it seeks to encourage continuing research into questions relating to regional development.

The institute views the study of regional development from a broad perspective and encourages a multidisciplinary approach including economics, economic geography, political science, public policy, and sociology.

The institute's goals are twofold:

1. To act as a catalyst in promoting informed public debate on regional development issues
2. To make available to all interested parties objective information and data pertaining to the study of regional development

Scholars with an interest in undertaking research on regional development issues are invited to contact the institute. Our Web site is: www.umoncton.ca/icrdr.

The Atlantic Canada Opportunities Agency (ACOA) represents the interests of the Atlantic region in Government of Canada policy making and has a mandate to encourage federal policies and programs which promote economic development in the four Atlantic provinces. In support of this role, ACOA carries out policy-relevant research on a broad range of issues, challenges, and opportunities associated with the development of the region's economy.

The Agency's policy research efforts are strategically focused and actively involve public and private sector partners and key stakeholders from across Atlantic Canada and outside the region. Partners include: independent public policy organizations; government departments and agencies; universities; colleges; economics community; business associations; and individual firms.

ACOA provided support to this study through the Atlantic Policy Research Initiative (APRI). The objective of the Initiative is to enhance the capability of the Agency to coordinate and plan pan-Atlantic federal activities contributing to economic growth in Atlantic Canada.

Innovation in Atlantic Canada

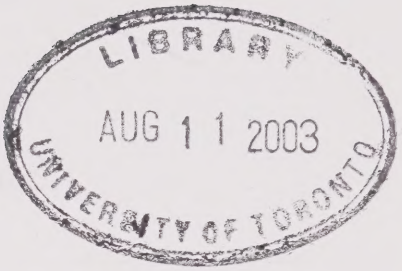
MARITIME Series

MONOGRAPHS

Yves Bourgeois
Samuel LeBlanc

Innovation in Atlantic Canada

INSTITUT CANADIEN DE RECHERCHE SUR LE DÉVELOPPEMENT RÉGIONAL
THE CANADIAN INSTITUTE FOR RESEARCH ON REGIONAL DEVELOPMENT



Graphic design: Raymond Thériault

ISBN 088659-083-3

Legal deposit: 4th quarter 2002
National Library of Canada

About the Authors

Yves Bourgeois is a researcher and Ph.D. student at the University of California at Los Angeles (UCLA). He completed his Bachelor of Arts in Politics and Economics at the Université de Moncton in 1993 and his Master of Arts in Philosophy, Politics, and Economics at the University of Oxford, England, in 1995. He worked for two years in Ottawa as a policy researcher for Senator Céline Hervieux-Payette before returning to complete a second master's degree, this one in technology studies at the University of Edinburgh, Scotland, in which he focused on the economics of technological innovation. Mr. Bourgeois worked for Microsoft Australia and as a consultant to other private sector ICT firms before enrolling in the Ph.D. program in regional political economy at UCLA. His research focuses on innovation and regional economic development, and he has also published on questions of globalization and Atlantic Canadian urban restructuring.

Samuel LeBlanc joined the Canadian Institute for Research on Regional Development in 2001 as an economics researcher. He earned a Bachelor of Arts (honours in Economics) from the Université de Moncton in 1995, and a Master of Economics from the University of Montreal in 1997. During his stay in Montreal, he contributed to a study on tele-care, under the direction of Dr. Jocelyne Picot, for Industry Canada. At the end of this project, he enrolled in a philosophy program at McGill University, from which he received a Bachelor of Arts (honours in Philosophy) in 2000. He explored in particular the philosophy of human sciences in order to better understand the scope of economic theories. Within the field of regional economy, he focused his efforts on analyzing the innovation phenomenon in Atlantic Canada. Carried out with Yves Bourgeois, this is the first study of its kind in the region. His more recent work has dealt with the economy of culture, a discipline which is still on the fringes of traditional economic thinking. Mr. LeBlanc did research work at the institute until August 2002. He is now pursuing graduate studies in philosophy at King's College, London.

Acknowledgements

This monograph was jointly funded by the Atlantic Canada Opportunities Agency (ACOA) and the Canadian Institute for Research on Regional Development (CIRRD). The authors would like to thank both organizations for their financial, logistical, and intellectual support. Special thanks go to ACOA for its initial enthusiasm for the project and to all the people who commented on earlier versions of this research, especially to Wade Aucoin for his comments and support at all levels. At the CIRRD, the authors are greatly indebted to Donald J. Savoie for his mentoring and support, to Marc Johnson for his invaluable comments and project leadership, to Maurice Beaudin for his ever-helpful advice and comments, and to Ginette Benoit for her zealous efforts in ensuring that the various drafts were legible and on time.

The authors would also like to thank a number of other individuals whose support improved the research immensely. They include Ian Fowler at Industry Canada for numerous contacts and references, Wendy MacDonald for her wealth of knowledge, and Michael Storper for his valuable comments. Finally, we are grateful to the translators and editors for their work in making our ideas clear and effective.

Contents

Introduction

This examination of Atlantic Canada's innovative capabilities is arranged in three parts. In the first part, we explore the relationship between innovation and economic development. Avoiding ready-made formulae that promote innovation for the sake of innovation, we consider the many facets of innovative activity and how they relate to economic growth. The second part uses the *1999 Survey of Innovation* and the *1999 Workplace and Employee Survey* to analyse the innovative performance of Atlantic Canada compared to other Canadian regions. And the third part explores the role of public policy and regional institutions in fostering Atlantic innovative capabilities. In the Conclusion, we suggest some policy recommendations based on our findings.

Stern, Porter, and Furman suggest that countries have varying *national innovative capacities*, i.e., the long-term ability to produce and commercialize innovative technologies.[1] In this study we examine Atlantic Canada's long-term ability to produce and commercialize innovations — in part 2 by comparing its performance to other parts of Canada and in part 3 by outlining a policy framework. We prefer the term *capabilities* instead of *capacities* because of the enabling connotation of the former, and we favour *regional* over *national* because relative gaps in innovative performance are as important intranationally as they are internationally.

We believe that the timing of our study is right for two reasons. First, the roller coaster ride that technology and technological innovation has been on in the popular media hinders a better understanding of the nature, role, and implications of innovation. Second, the last decade has witnessed the maturing of innovation research into a more sophisticated field of study. For these reasons, our intention in this study is to reflect innovation's expanding research base as well as the

1. S. Stern, M. Porter, and J. Furman, *The Determinants of National Innovative Capacity* (Cambridge, MA: National Bureau of Economic Research, 2000), Working Paper 7876.

growing concern for its contribution to regional development — and in a manner that avoids the unabashed enthusiasm or misguided pessimism of the popular media. In the end, the challenge for regional policy-making is to ground itself in a deeper appreciation of the role and dynamics of innovation.

A number of caveats to innovation and regional policy-making will be broached throughout this study. First, innovations are broad in nature and include such things as product, process, service, organization, etc. Policies that don't embrace this broad approach or are only one-dimensional are inadequate. Second, conflicts often arise between regional development objectives such as employment and income levels. Innovations may increase industrial productivity while they decrease the need for workers and their skills. They may also increase the wages of some workers at the expense of others. This is not to suggest that innovation and change should be discouraged, but blanket statements such as we "must embrace innovation" fail to appreciate the extent of the challenge involved. Given that innovation can take many different paths, the goal for regions is to develop the capabilities they need to shape future innovations and to provide longer-term choices that will increase both the profitability of firms and the wages of their workers. A third caveat is that even when stakeholders agree on regional-development priorities, deciding on how to achieve them can be contentious. A fourth caveat is that our analysis is biased towards the economic dimensions of innovation. There are, after all, wider objectives, such as improving quality of life and other social goals, to which innovation strategies and policies can make important contributions.

Part 1

Innovation Matters: The Importance of Knowledge, Technology, and Skills to Regional Development

Yves Bourgeois

Chapter 1

Innovation and Regional Economic Development

> It is almost universally accepted that technological change and other kinds of innovations are the most important sources of productivity growth and increased material welfare — and that this has been so for centuries.
>
> Charles Edquist, *Systems of Innovation*

The Edquist quote[1] attests to the attention that innovation has garnered to account for economic performance in policy, academic, business, and media circles. The literature abounds with references to the *new*, *knowledge-based* or *high-tech* economy, *information* or *digital* society, *learning* or *innovative* regions, and *smart* communities, as well as every possible permutation thereof. This waxing and waning of terms gives cynics the impression that business consultants are constantly firing new mantras across managerial bows, while glimmers of tenure and beyond is inspiring others to coin new paradigms to suit the times. As well, pessimists point to the recent tumult in the stock markets, as to prove that innovation is only a passing fad. In the end, linking innovation to business cycles and bubbles is short-sighted and unfruitful to policy-making.

The purpose of this chapter is to get beneath the accretion that has collected on the subject and uncover a more meaningful account of innovation and its impact on regional economic development. Knowledge-based economy, human capital, research and development (R & D), productivity, knowledge spillovers, and industrial clusters are the current buzzwords championed by economic policy-makers in Canada[2] and abroad as the keys to regional competitiveness. This chapter sets out to clarify these important concepts and to encourage the reader and policy-maker to question *why* each is important and *how* they can be promoted. By illustrating the intricate

1. C. Edquist, *Systems of Innovation: Technologies, Institutions, and Organizations* (London: Pinter, 1997), 1.
2. Government of Canada, *Achieving Excellence: Investing in People, Knowledge, and Opportunity. Canada's Innovation Strategy* (Ottawa: Industry Canada, 2002).

links connecting some of these concepts, the chapter argues the need for comprehensive innovation strategies beyond limited individual measures. At the same time, by showing how some concepts belong to different traditions in the economics of innovation, the chapter emphasizes the importance of clarity and precision while pursuing innovation policies. The overarching concern throughout this chapter is that although policy-makers now recognize the importance of innovation, a sense of urgency in "filling innovation gaps" may lead to errors in assessing the nature and importance of these gaps and result in the squandering of public and private investments.

Successful regional economic policies acknowledge the impact of innovation upon employment and growth. However, a regional innovation strategy by itself is incomplete if it does not reflect the industrial make-up of the region (what industries are located there) and the ways unique to each region by which firms organize, trade, and interact with each other and outside markets (how firms do business there). One size does not fit all. Innovation strategies must acknowledge the numerous sources of innovation by delving into the once "black box" of innovation and understanding its many underlying processes.

Although R & D labs and high-tech industries are the acclaimed sources of innovative activity, they are still only pieces of a much larger puzzle. Firms in traditional sectors without research labs innovate every day, transforming new ideas into profitable products and production processes. They acquire ideas not from in-house R & D but by tapping into the knowledge and ingenuity of their workers, suppliers, and customers — by networking with research institutions, universities, competitors, governments, and other stakeholders. How these relationships are organized and evolve varies from one place to the next. The local context shapes how business and innovation are done, which explains why firms in similar industries operate differently whether along Route 128 or in the Silicon Valley, Kanata, or Summerside.

Although communities, government, and industry now recognize the importance of comprehensive innovation policies in promoting regional development, many current strategies remain blind to pitfalls that undermine their effectiveness and may lead to their failure. The purpose of this chapter is partly to identify three of these pitfalls in order to better formulate regional innovation strategies. First, it is disconcerting to see the number of industry and government publications that recognize the importance of innovation to economic

growth and yet make no effort to explain or understand how they are linked. Second, it is alarming how many documents and officials have credited innovation strategies with increasing R & D expenditures and creating clusters. While R & D spending can be a good indicator of innovative activity, it is not the only one, and it can be a limited prescription. As for clusters, although their creation is a desirable long-term outcome, seldom do strategies enhance the dynamics by which they are created and sustained. The third pitfall relates to the notion of *best practice*. It is indeed important to be attuned to industry and market developments in other parts of the world in order to adapt and flourish under changing conditions. Imitation can be a successful tool for firms and regions. On the other hand, there is a danger in assuming that one can emulate successful firms or regions by copying corporate strategies or local development efforts. The challenge is not simply to replicate best practices but to consider whether they would work in the local environment, and if so, how they can be adapted. What is good for General Motors may not always be good for the rest of the country. And what works for the Silicon Valley or Atlanta, let alone regions similar to Atlantic Canada, may not work here.

The first pitfall is addressed by outlining how innovation is linked to economic development. Discussion of the second pitfall concerns a variety of sources for innovation other than R & D, measures by which it can be enhanced, and how it can be cultivated. Also discussed are the dynamics by which these sources are localized and underpin clusters. The last section addresses the third pitfall by introducing geographic dimensions relevant to innovation in Atlantic Canada. The same theme is enlarged upon in part 3. Let us consider what we mean by innovation.

The Concept and Context of Innovation

Innovation encompasses a wide array of creative activities whose purpose is to increase market share or profitability at the firm level, or material welfare and quality of life at the societal level. Innovations may be new or significantly improved commodities (*product* or *service* innovations), production techniques (*process* innovations), or ways of organizing firms, of combining workers with machinery, including computers (*organizational* innovations). Innovation data from Statistics Canada, analyzed in part 2, focus on product and process innovations. These are relatively easy to assess and compute for statistical purposes, but more rigorous analyses of the impact of innovations invariably examine other dimensions such as organizational

innovations,[3] which require more detailed industry case studies. Moreover, product and process innovations provide insights into the innovative enthusiasm and success of firms, although by themselves they reveal little of the environment and incentives that enable firms to innovate, compete, and collaborate, or the value of the innovations under consideration.

The OECD *Oslo Manual* defines innovation as follows: "TPP innovation activities are all those scientific, technological, organisational, financial and commercial steps, including investment in new knowledge, which actually, or are intended to, lead to the implementation of technologically new or improved products or processes."[4] The narrower focus of *The Oslo Manual* on technological innovations is on standardizing data measurements, even though broader definitions may be more insightful.[5] In fact, the manual assigns a central role to organizational innovations: the recent OECD Analytical Report on *Technology, Productivity and Job Creation* discusses a considerable body of research showing that technological and organizational change are highly interconnected. The report clearly demonstrates that technological change both "calls for and results from institutional and organisational change." It is therefore appropriate that some information relating to organisational innovation is collected in conjunction with data about technological change, which, it is hoped, will lead to a measurement of its extent and importance to firms.[6]

Whether product, service, process, organizational, or other, innovations occur when new ideas and knowledge are applied to production or when existing knowledge is used in new activities. Knowledge and novelty are thus the common and essential characteristics of all

---

3. "Organisation is essentially a process for the gathering, management and use of information, and for the implementation of decisions based on such information. Such processes have a strongly intangible dimension, but taken together they make up the learning capacity of the firm and as such are a central element in innovation capacity": see OECD, *The Measurement of Scientific and Technological Activities: Proposed Guidelines for Collecting and Interpreting Technological Innovation Data — The Oslo Manual* (Paris, 1996), para. 119. Although it acknowledges the central role of organizational innovations, *The Oslo Manual* omits them from its list of recommended measures because of the difficulty in obtaining systematic data. The problem of measuring organizational innovations should be seen as a challenge to improve on existing techniques.
4. OECD, *The Oslo Manual*, para. 177.
5. For example, the Conference Board of Canada defines innovation as "a process through which economic value is extracted from knowledge through the generation, development and implementation of ideas to produce new or significantly improved products or processes": see Conference Board of Canada, *Collaborating for Innovation: 2nd Annual Innovation Report* (Ottawa, 2000), 6.
6. OECD, *The Oslo Manual*, para. 435.

innovations. The way in which valuable new knowledge is created and harvested is the Holy Grail that lures management consultants and innovation economists to the unfamiliar world of knowledge management, learning economies, and so forth.

We know that knowledge is cumulative and builds on yesterday's successes and failures. In other words, we stand on the shoulders of giants and are saved the trouble of reinventing the wheel. Cumulative knowledge in turn spurs *incremental* innovations, which is where innovators tinker with existing products and techniques and, in the process, encourage further developments along certain trajectories. Occasionally, either by design or happenstance, *radical* innovations emerge. They constitute departures or breaks from established ways of thinking or doing things, and, as a result, they significantly alter technologies and markets. For example, the introduction of Windows 95, 98, ME, and XP constituted incremental improvements, but the development of new computer languages (C++) and operating systems (e.g., DOS to Windows) resulted in the radical shaping of how codes are written and market shares distributed. Incremental innovations in fishing vessels and gear can make crews more productive, but radical innovations in container and processing techniques (e.g., so-called floating factories) can alter the production, division of labour, and even geography of who catches and processes fish and brings it to market. We understand that incremental and radical innovations present different implications for company profitability and regional growth, but we are unable to predict when radical innovations occur or immediately recognize when they have.

A common misconception is that innovations originate predominantly from scientific research carried out in R & D labs. Although the value of scientific research is important on several fronts, it is by no means the only source of innovations. This misconception and consequent confusion can be traced to Joseph Schumpeter's seminal works, in which he himself struggles to identify who is responsible for innovations. In his earlier works, Schumpeter (1934, 1939) is careful to distinguish between the inventor and the innovator. The inventor pursues scientific discoveries, but the entrepreneurial innovator is the one responsible for "combining" or bringing them into production. In *Risk, Uncertainty, and Profit*, Frank Knight argued as early as 1921 that not all uncertainties could be calculated as risk, and this explained the crucial role of entrepreneurs. Schumpeter expounded on this further by arguing, in light of imperfect information and incalculable returns on investment, that entrepreneurs were exceptional agents who willed

acts of innovation despite the hazards of uncertainty. By tapping into pools of knowledge, entrepreneurs unleash gales of creative destruction, sweeping inefficient, productivity-limited, and profit-squeezed incumbents asunder.

By 1942 Schumpeter had reduced his emphasis on heroic entrepreneurs and was focusing instead on larger firms in monopolistic industries, where economies of scale and market power enabled them to finance and produce unforeseen innovations as a result of research and development. Some firms were beginning to develop specialized R & D divisions as well as hire scientists and engineers, whom Schumpeter now saw as those responsible for most innovations.

The shift in Schumpeter's own analysis anticipated a *linear* view of innovation, which was generally embraced from the 1940s through to the 1980s. Linear models view R & D as a deliberate response to market incentives first to create and then to commercialize valuable knowledge into new products and processes. The conception of innovation as a deliberate and neat sequence of company activities originating with scientific research has unfortunately proven itself too limited for three reasons.

First, we are often reminded of the fortuitous nature of many important discoveries, such as dynamite by Nobel, radioactivity by Röntgen, penicillin by Fleming, Velcro by De Mestral and microwave cooking by Raytheon. Pasteur may have been right when he observed that chance discoveries happen to prepared minds, but the essential point is that R & D may serve a more important purpose in increasing a firm's *absorptive* capacity,[7] i.e., its ability to integrate, although not necessarily generate, innovations.

Second, science-based R & D implies that knowledge can be deciphered from books and manuals or obtained from reverse-engineering competitor products. Reverse-engineering can reveal the chemical make-up of new compounds or complex processes, and copyright laws and patent protection ensure that discoverers are given incentives to innovate by guaranteeing temporary monopoly rents before generic companies can enter the market. In other cases, however, knowledge and techniques cannot be easily codified or diffused. They reside within the discoverers, skilled technicians, craftspeople and experienced workers. Gene splicers and wine makers, to name just two professions, acquire expertise not only by reading books, but through

7. W. M. Cohen and D. Levinthal, "Absorptive Capacity: A New Perspective on Learning and Innovation," *Administrative Science Quarterly* 35(1) (1990): 128.

long periods of trial and error (learning-by-doing) and by spending time with masters as apprentices or students. Forms of knowledge that are not easily disseminated are called *context-dependent* or *tacit* knowledge, as opposed to ubiquitous or codified knowledge. I will return to the notion of tacit knowledge later as it has crucial implications for regional development.

Third, linear R & D models of innovation overlook crucial sources of knowledge, such as workers, customers, and suppliers. The OECD *Oslo Manual* writes that innovation "is not a linear process and there may be important loops back in the system."[8] As early as 1965, Hollander examined innovative practices at DuPont, the chemical manufacturer and perhaps epitome of R & D activity, and found that most innovations emanated not from their R & D labs but rather from hundreds of incremental equipment and organizational improvements that originated with engineers, technicians, managers, and maintenance and production workers. Hence, the most important innovations may not come from lab research but from the shop floor and from market interactions. The growing recognition of the diversity of innovation sources is reprised in this chapter's sections on evolutionary economics and sources of innovation.

Leaving aside for a moment the sources of innovation, its prominence in academic and policy analysis can be attributed to two main reasons. First, the 1990s have heightened the attention given to productivity gains. Innovations and information and communication technologies (ICTs) in particular may enable workers and firms either to produce more goods and services or to produce them more efficiently than before. Just how much the ICT revolution has affected productivity levels is currently a topic of heated debate.

Second, knowledge and innovations may be crucial to explaining longer-term growth — beyond monthly or yearly productivity levels. Innovations may be fundamentally reshaping the structure of markets, products, and technologies. Just as the mill wheel and steam helped usher in the first industrial revolution, so, some argue, computers and telecommunications are revolutionizing our economy by increasing our capacity to produce, process, store, and transmit information. The advent of the railway and telegraph in the nineteenth century is often paralleled to computers and telecommunications in the twentieth century. Rail revolutionized transportation and propelled inland travel and settlement, while the telegraph made possible

8. OECD, *The Oslo Manual*, para. 33.

instantaneous communication across great distances long before the telephone or the Internet. By reducing the constraints on distance (i.e., transportation time and costs), rail and telegraph changed the relationship between cities, opening new markets and providing greater opportunities for trade and specialization. Rail enabled cities to expand, partly because food could be grown much farther from urban centre and still be shipped fresh to market. As a consequence, landlocked settlements such as Winnipeg and Moncton flourished. Infrastructure developments were accompanied, not coincidentally, by economic reorganization, with modern corporations emerging and industrial capital concentrating in the US northeast and central Canada.

The historic role of ICTs has its skeptics. Influential economist Paul Krugman questions the claims that knowledge and ideas are increasingly important to production. Resources and manufactured goods remain most important because consumers ultimately buy tangible goods.[9] Both Krugman and Gordon[10] remind us of the fundamental economic principle that if information is becoming cheap, it must be losing value. Just as the number of farmers has declined because agriculture has become more efficient, so will the number of white-collar workers decrease as we become better at producing information and computerizing routine tasks. This note of caution is important, because although ICTs may be reshaping the economic landscape, we don't know how extensive the changes will be or their result. Even if the extent of these changes is substantial, not all outcomes may be desirable. Although the railroad favoured the establishment of small towns along its path and turned them into distribution centres, it also helped concentrate, not disperse, industrial activity and wealth, organizing them in large centres such as Montreal and Toronto. Similarly, ICTs may enable remote areas to attract information-intensive operations such as call centres, but innovation-intensive and higher income-generating sectors have grown faster in large cities. Policy-making should be careful about regarding the ICT revolution as a panacea for regional economic development.

A big-picture view of technological and economic change remains important in interpreting major social and economic change. For instance, we hailed small and medium enterprises (SMEs) as the

9. P. Krugman, "White Collars Turn Blue," *New York Times Magazine* (29 September 1996).
10. R. Gordon, *Does the "New Economy" Measure Up to the Great Inventions of the Past?* (Cambridge, MA: National Bureau of Economic Research, 2001),Working Paper 7833.

main job creators of the 1990s, but less clear is whether this is more the result of entrepreneurs generating opportunities than the effect of large corporations shedding less profitable activities. Has there really been a substantial shift toward service-sector employment, or have large manufacturing companies increased the outsourcing of internal service operations to stand-alone producer-services firms?

Innovation and Economic Growth: Two Traditions

So far, I have argued that we need a much broader understanding of innovation and its sources than the one provided by the linear approach to R & D investments if innovative strategies are to reap the greatest economic benefits. Even if rapid innovations in ICTs are changing the ways businesses organize, operate, and locate some activities, that is not to say that location no longer matters. Changing trade patterns does not imply a borderless world where geography is irrelevant, nor does the penetration of ICTs into all economic activities signal a digital age where the production value of information trumps tangible goods. The need is as great as ever to link innovation policies and strategies with sound economic and geographic principles. Two main traditions in economics attempt to do this — neoclassical and evolutionary economics — and both are described in the following sections.

It is easy to say we need to embrace innovation, to become innovative regions with innovative firms. The goal, however, is not to become innovative for its own sake but to establish a link between innovation and increased material welfare and well-being, in particular to promote the productivity, profitability, market share, and growth of local firms as well as to increase job opportunities and income levels for local inhabitants. The purpose of this section is to identify some of these linkages between innovation, economic growth, and employment — linkages that are too often taken for granted in strategies and policies.

Though the notion of trade-offs is central to economics, it is conspicuously absent from many innovation strategies that advocate innovativeness with little regard for the myriad possible choices and outcomes. Many accept the idea that all innovations and technological changes are necessarily good, as if the only alternative were to choose outmoded products, tools, and processes, thereby condemning firms and regions to perpetual adversity. In fact, the choice is not between innovation and stagnation, but rather of which of the

several competing paths do firms and communities pursue. Do firms introduce labour-saving technologies to minimize costs, or do they invest in technologies to increase worker skills? Innovations can destroy jobs as well as create them, just as they can devalue worker skills and wages as well as increase them. Whether a region embraces innovation or adopts new technologies, the choice tells us little about regional-development outcomes because of the number of competing choices and trade-offs.

These choices often reflect the desire of businesses to pursue different market segments. When competing for mass markets (where lower prices rule), reducing operating costs becomes imperative and may warrant cheaper, labour-saving technologies. If competing for niche markets (where quality relative to price becomes more important), firms may invest in technologies that increase worker skills, whose premium now earns them higher wages. Most firms would prefer building competitive advantages that emphasize higher quality rather than lower prices, although local firms in fact evaluate their chances of success in choosing relative price or quality-driven strategies depending on how they assess changing market conditions and the resources at their disposal, including financing and regional labour skills.

In the short-term, it may matter less to firms whether they increase profits by lowering their bottom-line with cheap labour-saving technologies or by increasing revenue with higher-quality products produced by expensive but more productive physical and human capital. In the long run, low-cost strategies in a context of increased trade with industrializing countries having even lower costs may undermine industry sustainability. Moreover, the technological choices firms make can have conflicting impacts upon regions. Are regions successful if local firms increase their profitability and the wages of some workers at the expense of laying off others and increasing the region's unemployment rate? And are regions successful if local firms specialize in profitable, low-cost activities in the short run, but which become less sustainable in the longer run?

Local choices at the company level can thus have conflicting impacts upon regional objectives. In some cases local technological choices are constrained by forces and standards from outside the region. Local choices could then mean bucking wider industry trends, which would make them inordinately expensive. In other cases, technological choices and industry innovations that originate outside the region can have inescapable consequences locally. Decisions regarding

new technologies by Canada's big five banks are made in Toronto, but when those decisions lead to consolidating activities it can mean the closure of local branches far from corporate headquarters. New technologies allow the outsourcing of activities such as telebanking and customer service, but the question becomes whether these activities and jobs are sustainable or can be made obsolete by new technological (Internet banking) or location choices (cheaper locations).

Tradition 1: Neoclassical Economic Models of Growth

This section draws upon economic theory not as a purely academic exercise but to better anchor regional innovation strategies. The first broad tradition in explaining economic growth concerns itself foremost with the factors that enter into production: labour and physical capital. Economies grow when there are improvements in terms of increased labour, increased capital, or better combinations thereof. How these occur is the subject of debate, but improvements result from the following:

1. Trade, which optimizes the use of production factors
2. Increasing returns to scale
3. Qualitative or endogenous improvements to existing production factors

1. Trade-led growth

Trade models based on Ricardian principles of comparative advantage suggest that domestic economies have much to gain from international trade and competition. Countries benefit from specializing in industries that use factors of production with which they are relatively most endowed. Capital-rich countries should produce goods that use higher levels of technology, while countries with cheaper labour should produce labour-intensive goods. By specializing in what they do best, regions produce more goods on aggregate and can exchange surpluses, and, theoretically, everyone gains. Removing impediments to factor mobility equalizes prices on those factors over time, leading to converging per capita income throughout the world. The problem is that economists don't understand how important trade is to growth. Some argue that trade liberalization has been pursued because of prior and successful domestic industrial policies, and not the other way around.[11] Trade may facilitate but not necessarily explain growth.

---

11. See D. Rodrik, "Trading in Illusions," *Foreign Policy* 123 (2001): 55–62.

2. Increasing returns to scale

Models of increasing returns to scale highlight two flawed assumptions of conventional neoclassical theory: increasing the use of an input increases output at a slower rate (decreasing returns to scale); capital and labour can be shifted effortlessly from one location to another (perfect-factor mobility). Krugman challenges these assumptions by arguing that geography matters for two main reasons: higher value-adding industrial activity agglomerates in wealthy regions owing to economies of scale and distance decay in the movement of goods. In other words, industries cluster because output can grow proportionately faster where capital and labour are concentrated and where transportation costs are important.[12]

3. Exogenous and endogenous models of technical and technological change

If models of trade and increasing returns to scale attribute growth to the number or concentration of inputs, proponents of *new-growth* or *endogenous-growth* models emphasize qualitative changes in inputs. Growth has less to do with specialization and trade or the concentration of factors and more to do with how regions improve existing physical capital and labour. By comparing inputs to ingredients and production to recipes, Romer argues that growth comes from rearranging resources in more valuable ways — by improving recipes and not simply by cooking more.[13] When an economy's stock of physical capital (machinery, equipment) and labour (working population) is tabulated from one period to the next, its growth is often inferior to the growth in overall gross domestic product (GDP). There remains a *residual* value, an unexplained cause of growth, beyond the mere increase of capital and labour. Nobel Laureate economist Gary Becker writes: "A substantial growth in income in the United States remains after the growth in physical capital and labour has been accounted for."[14] Becker adds: "The search for better explanations has led to improved measures of physical capital and to an interest in less tangible entities, such as technological change and human capital."[15]

---

12. See P. Krugman, *Geography and Trade* (Cambridge, MA: MIT Press, 1991); P. Krugman, *Development, Geography, and Economic Theory* (Cambridge, MA: MIT Press, 1995); M. Fujita, P. Krugman, and A. Venables, *The Spatial Economy: Cities, Regions, and International Trade* (Cambridge, MA: MIT Press, 1999).
13. See P. Romer, "The Origins of Endogenous Growth," *Journal of Economic Perspectives* 8 (1994): 3–22; P. Romer, "Endogenous Technological Change," *Journal of Political Economy* 98 (1990): S71–S102.
14. G. Becker, *Human Capital*, 3d ed. (Chicago: University of Chicago Press, 1993), xxi.
15. Ibid., 12.

Explaining this growth residual has thus spawned two variants of endogenous-growth models, depending on whether improving the quality of physical capital (technological change) or labour (human capital) best explains growth. I further elaborate on these variants below because they pay the most attention to innovation and learning within the neoclassical tradition.

Knowledge, Productivity, Technological Change, and Human Capital

The neoclassical tradition distinguishes between *technical* change and *technological* change. Technical change consists of movements along the production-function curve when relative factor price changes induce labour- or capital-saving techniques. Technological change, on the other hand, occurs when the production-function curve itself shifts outwards. Better knowledge improves production by raising the productivity of physical capital. Solow theorized that as much as 87.5 percent of US per capita GDP growth between 1909 and 1949 was fueled by technological progress, although economists have since revised Solow's accounting on the grounds that technological progress is already embodied in capital goods or technology.

Economists now couch Solow's growth residual in terms of total-factor or multifactor productivity (TFP or MFP). Rising or stagnant productivity levels have garnered a lot of recent attention from economists and policy-makers. Some suggest that technological change may be the main reason why G7 economies have kept growing,[16] especially between 1995 and 2000.[17] The main debates here concern disaggregated productivity levels. Whereas some claim that TFP may be rising only in new manufacturing sectors like computers and telecommunications,[18] others argue that the most significant productivity gains have come not from ICT producers but from those integrating ICTs into production.[19]

---

16. M. Boskin and L. Lau, *Generalized Solow-Neutral Technical Progress and Postwar Economic Growth* (Cambridge, MA: National Bureau of Economic Research, 2000), Working Paper 8023.
17. S. Basu, J. Fernald, and M. Shapiro, *Productivity Growth in the 1990s: Technology, Utilization, or Adjustment?* (Cambridge, MA: National Bureau of Economic Research, 2001), Working Paper 8359.
18. See Gordon, *Does the "New Economy" Measure Up?*; W. Nordhaus, *Productivity Growth and the New Economy* (Cambridge, MA: National Bureau of Economic Research, 2001), Working Paper 8096.
19. M. Baily and R. Lawrence, *Do We Have a New E-conomy?* (Cambridge, MA: National Bureau of Economic Research, 2001), Working Paper 8243.

Robert Solow once quipped that computers were everywhere except in productivity statistics. However, economists, including Solow, now acknowledge that productivity gains from capital investments, such as in computers, come less from the equipment itself and more from how firms adapt in using it.[20] Wal-Mart's success is attributed to its innovations in combining computers with warehousing logistics, data interchanges, and wireless bar coding.[21] According to Solow, "Our historical research emphasis focusing on measuring R & D spending as a proxy for innovation is probably a mistake. I do think that's a gap — that we don't look enough at organizational innovation as in this Wal-Mart case."[22]

If endogenous models of technological change focus on how knowledge improves the productivity of *physical* capital, human-capital theory argues that knowledge plays a more important role in improving the productivity of *labour*. Gary Becker, whose seminal work on human-capital theory earned him the 1992 Nobel Prize, writes, "The primary determinant of a country's standard of living is how well it succeeds in developing and utilizing the skills, knowledge, health and habits of its population."[23] Individuals possess an ensemble of skills that are an integral part of their makeup. "[Expenditures on education, training, medical care, etc.] produce human, not physical or financial, capital because you cannot separate a person from his or her knowledge, skills, health, or values the way it is possible to move financial or physical assets while the owner stays put."[24] The value of technology depends on the skills of those using it. This suggests a complementarity between labour and technology, but Becker is clear that skills are primary and that technologies follow. Skills enable individuals not only to create tools but also to use them more effectively and hence increase productivity for their own benefit (higher wages), for the benefit of the firm (profits), and for the benefit of society as a whole (GDP). Like all forms of capital, human capital can depreciate (memory loss, outdated skills), but it can also accrue as the result of investments (tuition, foregone salary) made with the expectation of higher lifetime wages. The theory suggests that governments are best suited to fund general schooling, while individuals should pay vocational training and companies should provide firm-specific training.

---

20. Ibid.
21. McKinsey Global Institute, *Productivity in the United States* (October 2001).
22. M. Schrage, "Wal-Mart Trumps Moore's Law," *Technology Review* (March 2002): 21.
23. G. Becker, *Human Capital and Poverty Alleviation*, (Washington, D.C.: World Bank Human Capital Development and Operations Policy, Working Paper, 1994), 1.
24. Becker, *Human Capital*, 16.

Debates and Limitations

Within the neoclassical tradition, growth theories based on endogenous technological change and human capital development make the most persuasive case for why innovations matter to economic growth, although they are not without their critics inside the tradition. If Becker attributed the rapid growth of East Asian tigers to human-capital improvements, Krugman replied that increased workforce participation and not skills development should be given the real credit.[25] Easterly and Levine summarize recent empirical evidence and conclude that long-term growth cannot be explained by models of diminishing returns, constant returns to scale, fixed factors of production, or increases in the supply of factors.[26] The question then is, what can we say with certainty about factor-accumulation models in our quest to link innovation strategies with growth?

First, investments in innovations and human skills can improve total-factor productivity and labour productivity, and both are important to regional economic growth. In his critique, Krugman doesn't question that knowledge through technology and skills affects production and growth, but he does doubt that it plays as significant a role as Becker argues. Therefore, the challenge to innovation strategies is first and foremost to show how policies have affected or purport to affect labour and total-factor productivity levels. And second, whether trade is an engine or a lubricator of growth, trade promotion remains an important complement to innovation strategies, and it plays a key role in the diffusion of technological innovations.

The explanatory power of these models is based on key assumptions about the behaviour of people and firms. Broadly speaking, markets provide the optimal allocation of resources because free individuals and firms use perfect information to make rational decisions, enabling them to maximize their value or profits by freely shifting resources over space. These assumptions, insofar as they are accurate, help explain and predict how individuals and firms react to economic incentives. However, the assumptions are too simplistic to offer a meaningful account of the phenomena, and economists are increasingly doing one of two things.

---

25. Ibid.; P. Krugman, "The Myth of Asia's Miracle," *Foreign Affairs* (November-December 1994).
26. W. Easterly and R. Levine, "What Have We Learned from a Decade of Empirical Research on Growth? It's Not Factor Accumulation: Stylized Facts and Growth Models," *World Bank Economic Review* 15(2) (2001): 177–219.

At one level, some endeavour to improve upon core assumptions. The most problematic of these is the assumption of perfect information. No economist believes people or firms can know everything, but there are those who argue that the market is there to price uncertainties. Yet as discussed earlier, the importance of entrepreneurs derives from the fact that there are uncertainties beyond calculable risk. Even when information is available, its acquisition has costs, and how best to minimize transaction costs explains how firms organize. The last twenty years has seen the maturing of information and of institutional and organizational economics to remedy these inadequate assumptions. Spatial economics has also forced the discipline to recognize the importance of location and the limits to factor mobility.

At a broader level, economists are increasingly recognizing the importance of the social and institutional context in which economic activities take place. Everyone now agree that secure investments depend upon a stable political system, but a growing number of people argue that institutions and cultural norms shape economic activity.[27] How firms, labour, governments, and other stakeholders interact helps explain why business gets done differently depending on its location — whether in small communities or large cities, whether in Canada or Japan.

Tradition 2: Evolutionary Economics

Evolutionary economics has recently regained prominence — especially because of the pivotal work of Nelson and Winter[28] — on account of its ability to better explain evolving economic structures, markets, and technologies. The main differences between neoclassical and evolutionary economics revolve around their assumptions about market equilibria, company behaviour, and decision-making.

Whereas the neoclassical tradition assumes that firms are profit *maximizing* (achieving the optimal allocation of resources), evolutionary economics assumes that they are profit "*satisficing*." Information is costly and imperfect, and there is no inherent reason to assume that individuals or firms would be able to acquire the knowledge that would also allow them to make the best possible allocation of resources. What firms do know, however, is when they are profit-

27. "[There] are specific institutional 'rules of the game' which regulate possible modes of organisation on a broad level, but within such institutional parameters firms can and do exhibit considerable diversity." OECD, *The Oslo Manual*, para. 119.

28. R. Nelson and S. Winter, *An Evolutionary Theory of Economic Change* (Cambridge, MA: Harvard University Press, 1982).

able and when they are not. If profitable, they repeat their profitable decision-making routines. If not, they can do one of three things: they can remain unprofitable and ultimately fail, they can change by imitating the routines of successful firms, or they can innovate and create entirely new routines. Why they become less profitable can be the result of several factors, including changing market demand, changing consumer preferences, or cheaper competitor prices from their own innovations. Changing markets, technologies, and preferences, as well as the impetus for firms to adapt to them, suggest important evolutionary processes beyond the capacity of conventional economics to explain.

Comparing this tradition to evolutionary biology, Nelson and Winter write of firms evolving like organisms. The evolutionary view demands that we no longer see markets, preferences, and technologies as static or given entities against which firms make profit-maximizing decisions. Instead they are presented as moving targets, the direction and speed of which are uncertain because they evolve in unpredictable environments. Change is thus as endemic to economics as are equilibria.

Evolutionary biology uses the concept of punctuated equilibria to explain how organisms can thrive for long periods of time without undergoing noticeable change and then give way to sudden bouts of activity that dramatically reshape the landscape and its inhabitants. The result is that some perish while others successfully adapt. The same applies to firms during periods of economic restructuring. Once new equilibria are established, more conventional assumptions about markets and resource allocation may apply. There is no guarantee, of course, that all firms will survive the change. Schumpeter has written of the "gales of creative destruction" to describe the moments when entrepreneurs and firms seize opportunities to introduce new products, processes, and forms of organization that reap larger rewards and make traditional firms and techniques redundant.

When specific industries rapidly evolve, evolutionary economics suggests that technological choices are not necessarily optimal. For example, David (1985) argues that the standard layout of the QWERTY typewriter or computer keyboard places greater demands on the typist's left and thus limits typing speed. Better layouts have been developed, but the widespread adoption of the less optimal QWERTY has made the cost of switching to new configurations too high. Evolutionary economics applies this logic to technological innovations in general, arguing that innovations follow trajectories

that are path dependent — that is, new innovations will typically build upon previous advances incrementally, whether optimal or not, because introducing new standards can impose exorbitant costs upon individual producers. Dominant technologies emerge from the accumulation and synthesis of other technologies with proven track records. Once they achieve a critical mass of industry followers, trajectories engender incremental improvements that legitimate and reinforce the technological order. Incremental innovations continue until punctuated by radical innovations that prove themselves technically superior or desirable enough to overcome the scale and efficiency afforded by the widespread use of existing technologies.

The pre-Nintendo generation will recall a time when the electronics industry sought to introduce a new standard for home-video recording (VCRs). Beta was said to be technically superior, yet few consumers were willing to part with their "inferior" VHS investments. Beta disappeared and future improvements followed the VHS trajectory (Rosenbloom and Abernathy 1982), at least until large electronics firms embraced digital technology. Given the failure to introduce Beta and DATs alongside VHS and compact disks, there were no guarantees that consumers would embrace DVD technology, even if it was technically better. Large electronics firms needed to aggressively market the new product and convince consumers of its superiority. The VHS example illustrates the case of a trajectory that can lock in and brush aside technically superior challengers like Beta. (A high degree of uncertainty inhibits consumers from making a costly switch and discourages producers from investing in new plant technology.) Occasionally a breakthrough technology emerges that, once it establishes a critical mass or threshold, compels producers and consumers to invest in it or be left out. New trajectories can be particularly costly for producers who are late to convert. For example, some magnetic-tape manufacturers successfully switched to laser-disk production, while others lost market share to new firms that were quicker off the mark.

Knowledge Production and Value

Evolutionary economics relates knowledge production to economic development in two ways. First, it implies that the importance of knowledge is different from its value or profitability. I cited earlier Krugman's insight that as we get better at producing knowledge, economics tells us it diminishes in economic value. However, it does not make it less important. Employers would not be willing to fund gen-

eral schooling because the knowledge it imparts is not specific enough to the needs of the firm. And yet without general schooling employees would not possess the basic language, math, and social skills that are essential to acquiring the specialized knowledge demanded by firms. Schooling and basic research are examples of public goods that governments finance because they produce knowledge valuable to the economy but not necessarily profitable to individual firms.

In cases where knowledge is profitable, some firms reap greater profits than others. When knowledge is widespread, easily imitated, and diffused, it will not be very profitable because it would take little effort for any competing firm or region to produce it. Here is where Krugman is right. Regardless of the degree of knowledge-intensity, and even if the service rendered is knowledge itself (news, answering service), its value diminishes according to the ease with which competitors can replicate. We often overstate the importance of knowledge-intensive industries and economies because we focus on knowledge-*intensity* rather than knowledge-*scarcity*.

"The ability to generate high-quality, timely information and to make it available to potential users for commercial exploitation in Canada is essential to knowledge-based economic growth."[29] The excerpt acknowledges the quality and timely dimensions of valuable knowledge, and we must also consider its geography.

Valuable knowledge becomes more profitable when it is scarce, when it is not easily understood outside the context in which it is produced, or when evolving markets and technologies are constantly producing or replacing it. In such cases, knowledge is not easily diffused because competing firms and regions can only imitate it partially when it is context-dependent or are late in producing it when ideas succeed rapidly. Employers at innovative firms pay premium wages and customers pay premium prices for their products when skilled workers possess poorly diffusible knowledge in evolving, uncertain markets.

Firms that produce goods or services that seem knowledge-intensive, such as retail computer or insurance products, where costly research has gone into microchips and health risks, cannot claim high prices for their knowledge because it is more ubiquitous and therefore widely diffused among competitors. The assembly of computer components can be undertaken in Singapore or Ireland because

---

29. Government of Canada, *Science and Technology for the New Century: A Federal Strategy* (Ottawa, 1996), 31.

production techniques are standardized. However, the research and production of computer chips and components have remained highly clustered activities because relevant knowledge and research are fast-evolving, more sophisticated, and more difficult to replicate. Call centres employ sophisticated, knowledge-intensive IT and telephony systems, but their knowledge value is more in the design of the software and telecommunications infrastructure, activities largely undertaken outside the region, and less in the services provided.

Second, knowledge production relates to economic development because "sticky," or poorly diffusible, knowledge[30] creates localized externalities. Firms cluster to capture positive externalities (knowledge spillovers, skilled-labour pools, stakeholder interdependencies) and minimize negative externalities (information costs on evolving markets and technologies, skilled-worker turnover). Sticky-knowledge production not only sustains static advantages through higher wages and profits, but it also creates dynamic competitive advantages and cumulative causation (virtuous-circle) effects, whereby firms emerge and relocate in a region to capture increasing externalities. If the Silicon Valley or Montreal is the place to be for certain industrial activities, it is because there are external benefits and costs in those regions that firms and workers seek to maximize and minimize. These dynamic competitive advantages underpin the sustainability of clusters, an important feature of regional development strategies (see part 3).

Knowledge Stickiness in Time and Place: Timely and Tacit Knowledge

I have argued so far that the most profitable forms of knowledge are the ones that are sticky, not easily diffused. They garner higher wages and profits for those possessing them, and they generate localized externalities, the dynamics by which firms cluster in regions. There are two dimensions to this stickiness: time and space.

The economic value of knowledge-intensive industries lies partly in the fact that knowledge is important, even if it is both uncertain and constantly evolving. Timeliness in producing and adapting to ideas is critical. Financial institutions headquarter in Toronto, despite cheaper real estate and wages elsewhere in Canada, precisely because management divisions compete on the basis of the quality and timely nature of the information they get from their sources and in turn pro-

30. What C. Bekar and R. Lipsey call "geographically-limited knowledge." "Clusters and Economic Policy," *Canadian Journal of Policy Research*, 3(1) (Spring 2002): 63.

vide to their institutional clients. They need to locate where people are *in the know* and *have to know*. If they were always a day late with information, they would not be able to compete in such lucrative and sensitive markets. Much of the fuss about the ICT revolution is that Internet-based technologies are meant to render information instantaneously. Although communications have accelerated the absolute speed and amount of information diffused, clearly there remain relative advantages to be the first to know. It is for this reason that financial centres like London, New York, Tokyo, and Toronto have maintained their importance. Enthusiasm in the management literature over efficient supply chains attests to the ever-growing importance in some industries of *timeliness* over *instantaneity*.

The ICT revolution is also said to improve the quality of the information transmitted through on-line collaboration and video-conferencing. Again, ICTs clearly affect how firms and industries now conduct business, but we must also question why, in the Internet age of instant e-mails, cell phones, and broadband video, business travel has continued to increase. If distance no longer matters, why have overnight courier services become so pervasive and profitable? And why are cities spending so much effort improving the quality and efficiency of cargo and commuter airport facilities? Clearly, in many cases, there is no substitute for *being there*. If e-mails and the telephone are timelier than business travel, and still the latter continues to increase, then sticky knowledge must also depend on place.

There are two main reasons why knowledge is sticky in space, and both relate to how knowledge depends on context. First, Storper and Venables argue that in spite of the proliferation of electronic communication, face-to-face interaction, or buzz, is crucial to establishing the trust that is the basis of successful business relations.[31] Of course, retail customers may not need the same kind of interaction with manufacturers, because they trust Wal-Mart or Zellers to carry quality merchandise and to respond to dissatisfaction with a refund. On-line customers feel more secure about their purchases if the seller has an established reputation (word of mouth, media advertisement, seller ratings), if the seller is physically present (retailers selling goods both at outlets and on-line), and if the seller belongs to an on-line trust-verification service. Once relations of trust are established between partners, suppliers, and customers, electronic or on-line

31. M. Storper and A. Venables, *Buzz: The Economic Force of the City*, International Seminar on Economy and Space (Faculty of Economics, Federal University of Minas Gerais, Ouro Preto, Minas Gerais, Brazil, 6–7 December 2001).

communication can substitute for face to face. Until this trustworthiness is established, however, there is no substitute for a face-to-face encounter. Furthermore, face-to-face interaction allows for certain kinds of communication not easily conducted electronically. E-mail users know how easy it is to be misunderstood, and we use *emoticons* to alert the reader to sarcasm and humour. Verbal communication by itself lacks the physical cues such as gestures and facial expressions that can only be expressed in person — cues that are needed to accurately convey meaning and especially emotion. Consequently, if you want to communicate the urgency of a situation, close a deal, or convince business partners that you are aware of their concerns, there is no substitute for face-to-face interaction. Hence, face to face tells us that the quality of the knowledge diffused depends very much on having a physical presence.

The importance of context is also illustrated by the notion of *tacit* or *embedded* knowledge. These are forms of knowledge and know-how that are not easily codified or taught. Polanyi (1966) wrote that we know more than we can tell. A parent does not *tell* a child how to ride a bicycle; he goes outside and *shows* him. Receiving instructions over the telephone is more difficult than when they are explained in person. Management consultants are useful not for the reports they write but for their experience with new ideas and technologies and their ability to show clients how to integrate them into production. Some things are more easily learned when demonstrated by someone with experience; other things can only be learned through trial and error. For example, a person interested in auto repair may read a book on the subject, but mechanics and other skilled professionals learn their trade on the job — i.e., they learn by doing.[32] Arrow here was describing the importance of learning curves, insights we take for granted without fully understanding their economic implications. Like individuals, firms increase productivity not only through human capital and technology investments but also through experience — by practicing a task and getting better at it over time. "A key point from research on innovation is that much essential knowledge, particularly technological knowledge, is unwritten down. Thus, some kinds of information can only be transferred effectively between two experienced individuals — through transmission to a receptive individual who has enough expertise to understand it fully, or by physical transfer of the people who are carriers of the knowledge. It is *learning*

32. K. Arrow, "The Economic Implications of Learning by Doing," *Review of Economic Studies* 29 (1962): 155–73.

by firms as a whole (i.e., diffusion of knowledge to the board range of key individuals within them) that is critical to firms' innovative capabilities."[33] Experience with innovation also makes firms better innovators.

Experience can thus be expressed as the acquisition of tacit knowledge over time, knowledge that cannot be gleaned from books or manuals alone. This relates to the notion of routines, which is a central tenet of evolutionary economics. It also takes on a geographic dimension, because it suggests that valuable tacit knowledge resides within the firm or individual who possesses it, which is where they are situated. Hence management consultants impart their knowledge not from their desks but by meeting client managers and workers on the shop floor. Regions develop successful wine-growing or brewing industries — and other productive activities requiring expertise — by one of three ways: when expert wine makers or brewers bring their craft to new regions, when locals serve apprenticeships in successful wine and beer-making regions, or when locals endeavour over many years to perfect their craft. What is it about tacit knowledge and expertise that make them so difficult to diffuse, and how are they fostered? These are questions of keen interest to firms and regions. What we do know, however, is that their localized nature is what helps make them so valuable and conducive to knowledge spillovers. Tacit knowledge compels outside firms to locate where it exists, since understanding it requires interacting with those who know.

Knowledge, Learning, and Regional Development

The ability to make productive and profitable use of new forms of knowledge or its applications attests to a firm's or region's learning capacity. This capacity helps ensure innovative success over time. So far I have argued that knowledge and innovations are most profitable when they are sticky in time and space, when the quality and value of knowledge depend on *being first* or *being there*. Both have major implications for regional development because they provide the spatial impetus for firms to agglomerate in certain regions. They explain why higher value-adding activities and firms cluster in particular regions — why they pay higher wages and rents when cheaper locales exist elsewhere. They explain not only static but also dynamic regional competitive advantages that ensure industry sustainability over time. Yet if sticky knowledge compels innovative firms to agglomerate,

33. OECD, *The Oslo Manual*, para. 82.

then ubiquitous knowledge provides the motivation for firms to outsource those lesser value-adding activities to cheaper locations. Because knowledge-intensity can involve either sticky or ubiquitous knowledge, there is no guarantee that attracting firms that use knowledge intensively will reap important regional economic-development benefits. It is important for us to examine both the concentration of higher value-adding and the dispersal of lower value-adding activities — the positive and negative implications for regional development.

Evolutionary economics offers one of the best hopes for regional development on the grounds that regions with a strong innovative culture and capabilities are in the best position to seize new opportunities when abrupt technological changes do occur. When new, higher value-adding, knowledge-intensive activities emerge and before the pace of innovation slows and allows an industry to consolidate, there exist "windows of locational opportunity" that offer several regions the ability to capitalize on first-mover advantages. The uncertain nature of high-tech-product and industrial development suggests that neither firms nor other regional stakeholders can accurately predict breakthrough technologies, how industries will react and adopt them, and how regional assets will fare. Yet seizing upon such opportunities will not happen if the region and its firms possess few innovative capabilities — capabilities which can only be achieved through longer-term, coordinated investments in regional skills and knowledge production. This calls attention to the role of regional institutions and the importance of coordinated regional innovation policies and strategies — the focus of the next section.

When coupled with geography, evolutionary economics suggests that uncertainty encourages clustering. We know that industries in general, and high-tech industries in particular, agglomerate. And to explain why, I suggest four important reasons linked to the nature, availability, and production of knowledge and innovations.

1. Breakthrough technologies may rely on expertise that only a few star scientists possess

Early gene-splicing, microchip, and nano-technologies relied heavily not only on expensive research labs but also on researchers with the necessary know-how. Because some expertise has strong ties to star scientists, the best way to acquire this expertise is to collaborate with these scientists in the capacity of a student or colleague. When innovations continue in rapid succession and researchers are repeatedly developing new processes (e.g., new high-temperature superconduc-

tor compounds), the impetus to agglomerate perpetuates itself. Only later, after the initial pace of innovation has slowed, will the need to collaborate with star scientists subside.

2. Ongoing development requires pools of skilled labour

Breakthrough technologies in biotech industries, for example, result from the work of star scientists. They also rely on the work of a vast array of localized researchers. On one hand, breakthroughs spin off a flurry of activities that explore and develop new applications arising from the breakthrough. These activities are undertaken by university and industry researchers alike. Their subsequent work may also reveal important insights that over time lead to other breakthroughs. Cutting-edge and more routine research are thus mutually beneficial. These same circular effects apply to location decisions. In the software industry, new firms often locate close to other software firms because there exists in the region a labour force of programmers and engineers with the skills they need. Even if rents and wages are higher in that region, firms locate there either because talent outweighs costs or because it allows them to spread the risk. If production increases and they need to hire workers fast, they will benefit from the larger pool of skilled workers. Programmers and engineers employ a similar logic. If motivated by salaries, they will move to areas where employers pay premium wages. They also spread the risk, because if they should be laid off by their current employer, they would have a better chance of finding work in an area where there are many firms in the same industry. The mutual benefits of cutting-edge and routine research, as well as the mutual location choices of firms and skilled workers, create cumulative causation effects that reinforce a region's ability to capitalize on initial advantages. It also makes it difficult for other regions to establish competing agglomerations because it is not simply a question of attracting firms and workers but of reversing dynamics.

3. Commercializing innovations requires knowledgeable entrepreneurs and firms

Research and innovations do not commercialize themselves. In some cases, star scientists with a shrewd business sense patent or commercialize their own research. In other cases, entrepreneurs and entrepreneurial firms recognize the commercial value of ongoing research. This can mean start-up companies manufacturing new products from the research, or existing firms integrating research into improved production processes. Invariably the ability to com-

mercialize research depends on a firm's innovative capabilities — its ability to translate innovations into more valuable production. Here R & D spending takes on a greater role than the desire to develop new technologies that the literature often overvalues; it may serve an essential role in developing a firm's ability to recognize and incorporate valuable research from others. Simply collaborating with researchers will not generate economic benefits if a firm lacks the ability to understand the research and its implications. The spatial implications are twofold. First, firms in knowledge-intensive sectors that have invested in their innovative capabilities will benefit from collaborating with private and university researchers. Proximity to research centres becomes important, and firms tend to agglomerate or compensate for distance disadvantages through improved networking, such as participating in trade and technology fairs, sending workers to outside training, hiring consultants, and so forth. Second, proximity to research centres becomes paramount in sectors where the pace of innovation is particularly intense, a situation that makes distance much more difficult to overcome, because competitiveness comes from interaction and rapid adaptation. Moreover, benefits do not flow in only one direction; by collaborating with local research centres, knowledge-intensive firms enable future research projects to be undertaken. Again, such circumstances produce positive cumulative causation dynamics (virtuous circles) for a region — difficult to create, however, if a firm or region is late entering the game.

4. Technological innovations and commercialization depend on regional institutional and interfirm linkages

Knowledge-intensive industries not only require star scientists, skilled workers, and knowledgeable entrepreneurs; they also depend on the quality of the institutions underpinning collaborative activities. Institutions here are understood in a much broader sense than bureaucracies. They sustain the interactions in which firms are involved. Firms do not operate in a void. They make decisions bounded by their interactions not only with suppliers and customers but also with their competitors, service firms, research institutes, governments, communities, and so forth. At a minimum, firms depend on the expert knowledge of banks, venture capitalists, and other financial institutions because these sources are effective vehicles in acquiring market knowledge. They also make choices based on what local competitors do. The type and amount of R & D and worker-training investments depend on the quality of local research and

educational institutions. Governments also play key roles not just as soft (education) and hard (roads, telecommunications) infrastructure providers but by providing regulatory and cooperative environments that encourage investments and collaborations, as well as by being innovators themselves. These relations are bounded in space. The advice of financial institutions or management-consulting firms is only as valuable as the degree to which it reflects local conditions. Local markets may be less important if firms compete nationally and internationally, but regional education and training systems and local labour relations remain very important. Knowledge of local conditions helps make risk more assessable. For example, fewer firms get venture-capital funding in Atlantic Canada not because start-ups there are more likely to fail but because most venture capitalists in Toronto, Ottawa, and Montreal lack the knowledge of the local economy that would allow them to better assess the risk. And they are not prepared to locate there unless they know their efforts will be successful. In other words, there exist negative cumulative causation effects (vicious circles) that are harmful to regions.

Silicon Valley is a celebrated example of this. The proximity of silicon is undoubtedly the least important reason why the computer and software industry located there. Explanations vary between the pioneering work at Stanford University and the opportunism of key entrepreneurs; however, the fact remains that once it established its initial (first-mover) advantages, these became self-perpetuating, and no region has been able to rival Silicon Valley's success. In spite of this, one regional development effort sure to fail is to attempt a recreation of Silicon Valley. Strategies that have been more successful either have focused on creating dynamic and innovative competitive advantages targeting specialized software products for niche markets or have taken advantage of cost competitiveness to produce standardized products more cheaply.

If sticky or context-dependent knowledge induces firms to cluster their higher value-adding activities, ubiquitous or easily diffusible knowledge allows them to disperse less profitable ones. This presents an important challenge for regional development, because it invites less innovative regions to compete among themselves in attracting less profitable and lower-wage economic activities. When the intensity of breakthrough innovations subsides, industry practices and technologies standardize, activities including R & D routinize, and less profitable operations search for cheaper locales. Innovative regions establish dynamic competitive advantages through self-reinforcing

localized externalities, but less innovative regions are left to catch up or compete with cheaper costs.

Competing on cost places a smaller premium on worker skills and local knowledge, and may offer smaller benefits in terms of wages, regional income, and industry sustainability. Competing on product quality in higher value-added, segmented markets places a higher premium on skills and knowledge, which carry with them a greater potential for regional growth. However, given that these specialized markets are less certain and evolve faster, regions must have stronger innovative and learning capabilities to constantly stay ahead of both the learning curve and the competition in these more lucrative markets. The uncertain direction of technological development and changing market demand prioritizes interaction and hence proximity to larger markets (clients) and to their competitors and suppliers. It is this situation that determines how standards are eventually set. Firms in smaller areas face larger hurdles in meeting fast-evolving demand or setting industry-wide standards. If they pursue low-price, standardized-product markets, they can count on a relatively more stable demand; however, their growth opportunities will be limited by market share and their technological choices will be made elsewhere. Once regional competitive advantages are established, other regions must swim against the current to replicate first-mover advantages, in many cases an impossible task.

We should now have a fairly good idea of why knowledge-scarce industries cluster or agglomerate and why, despite the existence of cheaper locales elsewhere, they are willing to pay not only premium salaries and rents but also higher transportation costs to central markets. Not all forms of knowledge are equally valuable, and only those that are costly or difficult to replicate and diffuse will garner premium prices. This underscores the importance of inter-firm, firm-academia, and firm-institution collaborations (see part 2). It also underpins the dynamics that sustain clusters — the focus of regional-development initiatives even if they are not always understood. Regional innovative capabilities bolster the responsiveness of local firms to changing market demand and technologies in lucrative but fast-evolving sectors. At the same time, they accelerate the adoption of cost-saving innovations in mass markets for standardized products. The challenge for regional development is to foster this stickiness, i.e., localized knowledge production and learning capabilities. The path to success lies in organizing the many key intangibles by means of regional learning and institutions (see part 3).

Sources of Innovation

The purpose of this section is to recapitulate a main theme of this chapter and to show the diversity of sources from which innovations emanate. Each of these sources has been more or less described in the preceding pages, so they are only touched on here.

Table 1

Sources of Information for Innovation, According to the OECD *Oslo Manual*

Internal	External/ Commercial	Research Institutes	Generally Accessible
R & D	Competitors	Higher education	Publication of patents
Commercialization	Acquisition of protected technology	Public research institutes	Conferences, meetings, and trade publications
Production	Acquisition of nonprotected technology	Private research institutes	Trade fairs
Other	Clients, consulting firms, and suppliers		

Source: OECD, *The Oslo Manual*, para. 224; compiled by Yves Bourgeois.

Table 2

Factors Inhibiting Innovation, According to the OECD *Oslo Manual*

Economic	Firm-Level	Other
Perceived excessive risks	Insufficient R & D potential	Few technological opportunities
Excessive costs	Lack of skilled workers	Inadequate infrastructure
Inadequate sources of funding	Little information on technology	Prior innovations
Excessive rollout time	Insufficient market information	Inadequate intellectual property rights (IPR)
	Excessive costs	Regulatory, fiscal environment
	Resistance within firm	Lack of client interest
	Insufficient outside services	
	Lack of collaborative potential	

Source: OECD, *The Oslo Manual*, para. 226; compiled by Yves Bourgeois.

Research and Development

Research and development is often touted as the best means by which firms can innovate, with strong correlations being drawn between R & D spending and economic growth (Jones and Williams 2000; Keller 1997). A widely held view is that a firm's spending increases its ability to introduce innovations to the market. Governments also enhance a region's innovativeness — directly by funding applied research or indirectly by funding basic research and encouraging firms through R & D tax credits. Gross domestic expenditures in research and development (GERD) often serve as indicators of how innovative a region is or how committed it is to becoming innovative. It is worth recalling the OECD (*The Frascati Manual*, 1993) definition of R & D: "Research and experimental development (R & D) comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society and the use of this stock of knowledge to devise new applications."

There is also a debate as to which offers the greater benefits: funding for basic academic research or funding for applied industrial research.[34] The benefits of R & D depend not just on the weight given to commercialization, which varies significantly according to industry. Scientific research proves less valuable in process or incremental types of innovation. Subsidizing university research yields greater benefits for some industries, while offering R & D tax credits proves more beneficial for others. Moreover, some firms depend less on formal R & D and more on the activities and interactions between firms, suppliers, customers, and other users. Innovation policies limited to R & D subsidies or tax credits are biased towards industries and regions where R & D is a relatively more important source of innovation, at the expense of other industries and regions reliant on nonlaboratory and nonlinear sources of innovation.

"Initially, technological progress was assumed to be achieved through a simple linear process starting with basic scientific research and progressing in a straightforward manner through more applied levels of research, embodying the science in technological applications, and marketing. Science was seen as the driver, and all that government needed was science policy. Fresh thinking about innovation has brought out the importance of systems of innovation and led to a more integrated approach to the delivery of innovation-related policies."[35]

---

34. J. Adams, *Endogenous R & D Spillovers and Industrial Research Productivity* (Cambridge, MA: National Bureau of Economic Research, 2000), Working Paper 7484.

35. OECD, *The Oslo Manual*, para. 62.

Identifying which applied industrial research has greater commercial potential does not mean picking winners, but it does mean analyzing current regional competitive advantages as well as potential new ones. R & D subsidies should specifically target R & D projects that firms would not pursue without assistance, otherwise investments translate into higher wages for R & D workers because of their inelastic supply. Particular consideration should be given to industries where there may be greater potential for localized spillovers.

The greatest benefit of R & D spending may not be to increase a firm's ability to develop innovations; it may be to increase its ability to adopt and adapt them. There are greater opportunities to incorporate new innovations into existing production than to patent innovations. Achieving this requires only a minimum of *absorptive capabilities* acting as antennae and conduits for what is produced elsewhere. With the exception of the United States, all OECD countries obtain more ideas from abroad than domestically.[36]

Mergers, Trade, and the Acquisition of Innovations

Not all R & D needs to be conducted in-house. Some firms are successful at acquiring foreign technology and ideas and incorporating them into their own production systems. Patents can be purchased and protection circumvented through partnerships, mergers, and acquisitions of patent-holding firms. Some countries are revising antitrust laws based on the imperatives of increased international trade. Not all innovations involve patents, and many benefits are gained by learning from others and by adapting "best practices" to local and firm-specific contexts.

Foreign Direct Investments and Intermediate Goods

Foreign direct investments (FDIs) represent important channels for international knowledge and technological information spillovers.[37] In cases where knowledge is tacit (embodied in people or technologies), it may be difficult to acquire it directly. FDIs expose regions to new ideas and practices from multinational corporations (MNCs) and from relocated employees. Trade in intermediate goods allows firms along the value chain to make use of their suppliers' research activities, by reverse engineering semifinished goods or simply learning how better to adapt them for production.

---

36. J. Eaton and S. Kortum, "Trade in Ideas: Patenting and Productivity in the OECD," *Journal of International Economics* 40(3/4) (1996): 251–78.

37. L. Branstetter, *Is Foreign Direct Investment a Channel of Knowledge Spillovers? Evidence from Japan's FDI in the United States* (Cambridge, MA: National Bureau of Economic Research, 2000), Working Paper 8015.

Borensztein, De Gregorio, and Lee argue that where minimum levels of human capital exist, FDIs are important channels for technology transfers, contributing more to economic growth than domestic investments.[38] Kearns and Ruane found R & D–spending MNCs contributed more to the Irish domestic economy than non–R & D MNCs, and that they also tend to stay longer in the region and provide better-quality employment.[39]

Intermediate goods, also known as capital or semifinished goods, consist of machinery and equipment that enter into the production of other goods. They are of particular interest, first, because they underpin production in other industries and because innovations in that sector will likely have farther-reaching economic impacts than innovations in final-goods industries. Second, among intermediate goods are machinery and equipment that tend to be much more technologically sophisticated and require higher levels of worker skill, with the result that the workers concerned are better paid. Since many intermediate goods embody valuable tacit knowledge, they offer firms greater potential to learn (appropriate embodied knowledge) and to be innovative. Technologies embodied in intermediate goods transmit R & D investment benefits to domestic and foreign industries. The challenge remains as to how local firms can appropriate embodied knowledge.

Clusters and Knowledge Spillovers

Spillovers relate to localized externalities and how innovative firms cluster to maximize positive externalities and minimize negative ones.[40] Spillovers arise from the concentration of star scientists, skilled labour, knowledgeable entrepreneurs, and facilitating institutions. Zucker, Darby, and Armstrong found geographically localized effects for scientific discoveries in areas where scientists learned only by working with other discoverers.[41]

---

38. E. Borensztein, J. De Gregorio, and J. Lee, *How Does Foreign Direct Investment Affect Economic Growth?* (Cambridge, MA: National Bureau of Economic Research, 1995), Working Paper 5057.

39. A. Kearns and F. Ruane, "The Tangible Contribution of R & D-Spending Foreign-owned Plants to a Host Region: A Plant Level Study of the Irish Manufacturing Sector (1980–1996)," *Research Policy* 30(2) (2001): 227–44.

40. W. Keller, *The Geography and Channels of Diffusion at the World's Technology Frontier* (Cambridge, MA: National Bureau of Economic Research, 2001), Working Paper 8150.

41. L. Zucker, M. Darby, and J. Armstrong, "Intellectual Capital and the Firm: The Technology of Geographically Localized Knowledge Spillovers," *Economic Inquiry* 36 (1998): 65–86.

Both universities and regional governments recognize the economic benefits associated with academic research. Universities have created commercialization offices (technology transfer offices or TTOs) and licensing agreements, whose success hinges on reward systems for faculty and TTOs staffing and on the removal of information and cultural barriers between universities and firms.[42] Because they are more localized, spillovers from academic knowledge may ultimately benefit host regions more than industrial spillovers.[43] Policy-makers endeavour to create mechanisms and incentives to facilitate industry-academia collaboration. Research centres gain a better appreciation of local industrial needs, and firms gain a better appreciation of the research being conducted in related fields. The role of government in promoting and harvesting spillovers is not limited to that of facilitator. For example, the US government operates the world's largest system of research labs. As such, it is responsible for 14 percent of total US R & D, more than all universities and colleges combined.[44]

The dissemination of knowledge spillovers is not limited to academia, governments, or industry-specific firms. Producer-services firms such as industry consultants and venture capitalists also play key roles in creating and harvesting spillovers. By developing technical expertise in working with client firms, they invariably disseminate knowledge throughout the industry, greatly reducing firms' transaction costs.[45] One technique to overcome the difficulty in measuring localized spillovers is to examine patent citations as proxies, the implication being that researchers in closer proximity will cite each other more often.[46]

---

42. D. Siegel, D. Waldman, and A. Link, *Assessing the Impact of Organizational Practices on the Productivity of University Technology Transfer Offices: An Explanatory Study* (Cambridge, MA: National Bureau of Economic Research, 1999), Working Paper 7256.
43. J. Adams, *Comparative Localization of Academic and Industrial Spillovers* (Cambridge, MA: National Bureau of Economic Research, 2001), Working Paper 8292.
44. J. Adams, E. Chiang, and J. Jensen, *The Influence of Federal Laboratory R & D on Industrial Research* (Cambridge, MA: National Bureau of Economic Research, 2000), Working Paper 7612.
45. J. Gans, D. Hsu, and S. Stern, *When Does Start-up Innovation Spur the Gale of Creative Destruction?* (Cambridge, MA: National Bureau of Economic Research, 2000), Working Paper 7851.
46. A. Hu and A. Jaffe, *Patent Citations and International Knowledge Flow: The Case of Korea and Taiwan* (Cambridge, MA: National Bureau of Economic Research, 2001), Working Paper 8528.

Agglomeration, Creativity, and Learning

The literature on localized-knowledge spillovers summarized in the previous section has made two major contributions to innovation studies. First, innovations result not only from the deliberate, linear, and calculated returns from R & D investments but also from the tacit knowledge diffused through personal interactions. Second, it emphasizes the spatial dimensions of knowledge and innovation and thus recognizes that knowledge can be localized and can multiply economic benefits to the immediate region. And yet the explanation we have so far still hinges on the importance of research, and of researchers in particular. There exists another level of the analysis of the importance of geography and agglomeration that focuses on the role of cities in facilitating creativity and the production of knowledge[47] — tacit knowledge in particular[48] — through interactions and synergies.

Density increases the speed and number of interactions between individuals; it also adds to the diversity of skills[49] and industries.[50] Yet the importance of cities pertains to more than mere size and the specialization and scale that size affords. Black and Henderson argue that the economies of similar-sized cities can grow at different rates because of variations in human capital, spillovers, and how production is organized.[51] Differences in regional institutions can help explain how knowledge and learning are transmitted from one region to another.[52] Perhaps the most interesting ideas have involved examining the role of cities in inspiring and fostering creativity.[53] Most recently, Richard Florida developed a creativity index linking the innovative and economic success of cities to their ability to attract not only high-tech workers but also gays and those who work in creative industries. The latter are proxy measures to suggest that creativity, diversity, and tolerance are significant issues in attracting creative people. The important question we are only now addressing is why some cities are more creative than others.[54]

---

47. E. Glaeser, "Learning in Cities," *Journal of Urban Economics* 46(2) (1999): 254–77.
48. Storper and Venables, *Buzz*.
49. Glaeser, "Learning in Cities."
50. G. Hanson, *Scale Economies and the Geographic Concentration of Industry* (Cambridge, MA: National Bureau of Economic Research, 2000), Working Paper 8013.
51. D. Black and V. Henderson, "A Theory of Urban Growth," *Journal of Political Economy* 10(7) (1999): 252–84.
52. R. Hassink and A. Lagendijk, "The Dilemmas of Interregional Institutional Learning," *Environment and Planning C: Government and Policy* 19(1) (2001): 65–84.
53. E. Soja, *Postmetropolis* (Oxford: Blackwell, 2000).
54. R. Florida, *The Rise of the Creative Class* (New York: Basic Books, 2002).

To summarize, this section presented a variety of sources of innovation — from a simple linear view of firm-level, lab-driven R & D to the more complex relationships that underpin clusters and urban systems. Although measuring firm-level R & D activities is common practice because of the relative ease with which data are collected, it tells us little about the wider environment in which firms operate (for example, why some regions invest more in R & D) and what influences the level of private R & D investments. Moreover, by focusing on science-driven R & D, we ignore the more numerous sources of innovation that hold greater potential for a much larger number of firms. The rest of the section illustrated how researchers are trying to measure these sources of innovation, which are broader but more difficult to capture.

The implications for policy are twofold. First, do not restrict R & D to lab and science-driven research activities: R & D is best understood as problem-solving activities undertaken at all levels of a firm's operations. Second, it is important to exploit a firm's internal sources of innovation, such as increasing R & D investments and tapping into the knowledge and experience of all its workers. While company and regional-development efforts have often stopped there, strategies are now recognizing the importance of the following external sources of innovation:

- Relationships between firms along the value chain, especially those in close physical proximity
- Relationships with regional institutions, both formal (education, finance, government) and informal (labour relations, conventions and practices governing how firms collaborate, etc.)
- Creativity, synergism and complementarities generated by concentration or agglomeration in urban centres and spatially integrated communities

Measures of Innovation

If the preceding section illustrates the diverse sources of innovations, this section illustrates the problems in trying to measure innovative activity. Given the complex nature of innovation, researchers look for proxy variables to best approximate this elusive phenomenon. As innovation studies continue to mature, researchers settle for imperfect signposts, making trade-offs between ease in obtaining data (e.g., R & D expenditures) and their reliability. Given the embryonic nature of this research, benchmarking activities though important cannot by themselves suggest the existence of any *innovation gaps*.

Total-Factor Productivity

As discussed earlier, total factor or multi-factor productivity is a residual measure by which the economy has been able to produce more goods and services with the same amount of inputs. The residual nature of TFP makes it difficult to determine which sectors are relatively more important to GDP growth. Some suggest that the rapid productivity growth between 1995 and 1999 has been fuelled mostly[55] or entirely[56] by the durables-manufacturing sector. Others argue that ICT innovations increased productivity mostly outside of the computer sector, such as in finance and in retail and wholesale trade.[57] TFP is an important measure because it directly links knowledge and innovation to GPD growth, but the challenge is to obtain reliable measures disaggregated by sector and region.

Research and Development Expenditures

A widely held view is that a firm's spending increases its ability to introduce innovations to the market. Governments enhance a region's innovativeness directly by funding applied research or indirectly by funding basic research and encouraging firms through R & D tax credits. Gross domestic expenditures in research and development often serve as an indicator of how innovative a region is or how committed it is to becoming innovative.

There are important limitations on the use of R & D expenditures as a measure of innovativeness. Most importantly, as *The Frascati Manual* (1993) itself recognizes, R & D statistics are by themselves inadequate measures of innovativeness. R & D indicators are emphasized because of the ease with which they are collected. *The Frascati Manual* is particularly effective at defining R & D not in the narrow confines of basic or applied scientific research but in the much larger terms defined by "experimental research and design." In other words, a firm's tinkering with prototypes or new techniques through trial and error, for example, are equally important as scientific research.

---

55. Basu, Fernald, and Shapiro, *Productivity Growth in the 1990s*.

56. Gordon, *Does the "New Economy" Measure Up?*

57. Baily and Lawrence, *Do We Have a New E-conomy?*; McKinsey Global Institute, *Productivity in the United States*.

The Oslo Manual identifies two limitations: "First, R & D is an input. Although it is obviously related to technical change, it does not measure it. Second, R & D does not encompass all the efforts of firms and governments in this area, as there are other sources of technical change, such as learning-by-doing, which escape from this narrow definition."[58]

The measurements abound because of the relative ease with which such proxy variables can be obtained. Porter and Stern suggest that the link between generating new ideas and productivity growth is not particularly strong, partly because research and development are distinct activities.[59] It is relatively easy to measure how much a firm, an industry, or a region spends on research; however, we wrongly assume that research invariably returns benefits in terms of commercial development. The classic example of this is Japan developing its electronics sector because American firms were slow to recognize the commercial potential of 1950s' transistor research. Innovation policies bent on generating economic benefits must pay particular attention to the development side of the R & D nexus by targeting the ability of regional industries and firms to commercialize ideas, including those originating outside the region.

New Products and Processes

One of the limitations of R & D data is that though they are indicators of how much firms spend on innovative activity, they are only loosely correlated with how much firms produce: they measure research investment but not its output. Statistics Canada data on new or improved products and processes (introduced in the past year) are meant to better reflect the output of innovation that is more closely tied to economic benefits. The OECD *Oslo Manual* recommends measuring activities in three-year periods because of the sometimes lengthy innovative process. The manual also suggests the separate tabulation of firms that have pursued innovative activities without necessarily introducing new products or processes — perhaps because projects were aborted or are still underway — because such firms are distinct from those not engaged in any innovative work at all. The data provide valuable insights at an aggregate level but must

58. OECD, *The Oslo Manual*, para. 49.

59. M. Porter and S. Stern, *Measuring the "Ideas" Production Function: Evidence from International Patent Output* (Cambridge, MA: National Bureau of Economic Research, 2000), Working Paper 7891.

be complemented with industry-level case studies if the importance and not just the quantity of innovations is to be measured. The OECD *Oslo Manual* also cautions against exaggerating the importance of magic numbers, such as R & D as a percentage of GDP or the proportion of innovative firms.

Patents

Patents are another proxy variable that attempts to measure the output of innovation. "Patent statistics are increasingly used in various ways by technology students as indicators of the output of invention activities. The number of patents granted to a given firm or country may reflect its technological dynamism."[60] The assumption is that if firms, laboratories, and researchers produce commercially valuable new products or processes, they will want to protect their discoveries to ensure a financial return on their investments. Patents provide temporary monopoly rents on new ideas, preventing free-riding competitors from replicating costly discoveries. Without patent protection, firms have fewer incentives to invest in research. Patents eventually expire, however, and when they do, competitors move in, and consumers benefit from lower prices. The challenge is to give the innovative firm sufficient time to recover its R & D costs. In the pharmaceutical industry, the trade-off is apparent when generic-drug manufacturers and the general public accuse patent holders of price gouging, while the latter claim an appropriate return on their research investments.

Patent data offer a number of methodological advantages. First, the data are readily available. Second, they can be broken down geographically and by sector, allowing meaningful and detailed regional and industry comparisons. And third, because of its monopolistic nature, knowledge and innovations embodied in patents are more difficult to diffuse through the markets and so place a premium on the knowledge and skills embodied in the discovering firms or researchers. Spillovers generate new knowledge and commercial ideas, and the extent to which they become localized is crucial to economic development.[61] When knowledge is tacit (i.e., embodied in researchers and firms), it gives an impetus to collaboration and interaction.

---

60. OECD, *The Oslo Manual*, para. 50.

61. Hu and Jaffe, *Patent Citations and International Knowledge Flow*.

On the other hand, there are limitations on the usefulness of patent data. They treat all patented products and processes as equal, even if some have greater commercial value than others. Genetic-mapping firms take out large numbers of patents in the event that one area may become tomorrow's genetic gold mine. Patents in one industry may not necessarily reveal a greater degree of innovativeness. Their availability make them useful and encourage efforts to "reduce noise," to identify meaningful patents and couple them with other indicators.[62]

There are a number of other measures of science and technology (S+T) activity. Included here are bibliometrics, which measure scientific publications, and investments and employment in high-tech sectors, such as the number of scientists and engineers employed in a particular sector. Used in conjunction with other indicators, they help paint a more complete picture of S+T activity. Our interest, however, is in the role of all innovations in promoting regional economic growth. Since many innovations are not driven by science or R & D, S+T policies represent only one piece of the innovation puzzle. Innovation policies and strategies need to consider how all innovations can improve economic performance.

Innovation and Less-Advantaged Regions

Scale

Scale has long been a challenge for the Atlantic provinces, which have fewer than three million inhabitants dispersed among several small cities. Much of the discussion surrounding the integration of the Maritime provinces is driven by the notion of economies of scale, according to which the small size of the region is said to limit opportunities and options. Limited scale affects innovation in a myriad of ways, including higher transaction costs for SMEs,[63] small population base,[64] low worker-training investments, higher capital-goods prices,

---

62. A. Jaffe, "The US Patent System in Transition: Policy Innovation and the Innovation Process," *Research Policy* 29(4/5) (2000): 531–57; S. Stern, M. Porter, and J. Furman, *The Determinants of National Innovative Capacity* (Cambridge, MA: National Bureau of Economic Research, 2000), Working Paper 7876.

63. J. Britton, "Reconsidering Innovation Policy for Small- and Medium-Sized Enterprises: The Canadian Case," *Environment and Planning C: Government and Policy* 9 (1991): 189–206.

64. A. Cornford, *Innovation and Commercialization in Atlantic Canada*, report prepared for the Atlantic Canada Opportunities Agency, (Moncton, 2002), 19. "With a small population base and a limited number of researchers to bring the necessary talent to attract both academic talent and industry investment, institutes in Atlantic Canada may consider building alliances with *brain power* from outside the region."

and higher per-unit prices on infrastructure development. Increasing returns to scale can create virtuous circles of population growth and idea generation. Human-capital endowments produce cumulative effects and influence rates of technological progress.[65] The relative dearth of venture capital signals not only an absence of financial options but especially a lack of expert knowledge on which venture-capital firms are built.

There are ways in which regions can overcome deficiencies of scale. Collaboration between governments in general can improve upon the effectiveness of larger innovation-policy frameworks and strategies.[66] The promotion of Atlantic securities exchange and venture-capital markets are cases in point. Collaboration between government departments can also be beneficial, especially when efforts target similar industries and services (e.g., education and labour training). Often, the challenge is to overcome the parochialism of attracting jobs locally in order to promote sustainable and innovative industries regionally.[67] Scale can also be mitigated at the industry level through increased trade, which expands the market for exports, increases specialization, and enhances productivity. Specific to innovation, trade lowers prices on imports of intermediate goods. Trade policies are not a substitute for the promotion of productive and innovative capabilities, but trade can complement them by targeting higher value-adding sectors as well as by attracting FDI with an R & D bias, as they tend to stay in the region longer and offer higher-quality employment.[68]

Urbanization, Human Capital, and Mobility

The size of a region or its population may not be as detrimental to growth as the extent to which the population is urbanized. In the case of the Atlantic provinces, 52 percent of the population lives in

---

65. B. Jovanovic, "Vintage Capital and Inequality," *Review of Economic Dynamics* 1(2) (1998): 497–530; Boskin and Lau, *Generalized Solow-Neutral Technical Progress*.

66. "In this context, the notion of Atlantic political union is a red herring. Administrative rationalizations and mergers have a mixed record at best. The region is neither over-governed nor over-legislated. The challenge is quite different: Atlantic Canada is under-managed in a strategic sense, and under-organized around strategic objectives. [There is a] need for an Atlantic approach to administrative cooperation, policy integration, and most importantly, consistency of purpose": see C. McMillan, *Focusing on the Future: The New Atlantic Revolution* (Halifax: Council of Atlantic Provinces Premiers, 2001), 2.

67. "Many of the agencies in the region have unrealistic performance measures. They all have scarce resources, and almost all compete instead of cooperating effectively with each other. Yet, without partnership and concerted effort, the region as a whole will find it very difficult to compete internationally in innovation": see Cornford, *Innovation and Commercialization*, 9.

68. Kearns and Ruane, "Tangible Contribution."

cities, as compared to the Canadian average of 76 percent. Cities grow because of the scale and scope of their economies, which are bolstered by the diverse skills and industries they attract.[69] Cities can also grow from immigration, but this depends on the skill level of the existing population.[70] Immigration can produce human-capital externalities, since public investment in education in one region bears fruit elsewhere. Relatively low levels of immigration into Atlantic Canada point to the disadvantage of human-capital accumulation the region faces compared with more populous regions. The departure of skilled workers exacerbates the problem of emigration — a problem that is compounded if skilled couples prefer to live in metropolitan areas where suitable jobs are more available[71] and if large cities are disproportionately successful in attracting investments and skilled labour.[72]

Locating in small urban and rural areas need not mean fewer opportunities to innovate. Smallborne and North found that in the opinion of company managers, rural environments are not necessarily constraints on innovation, although they may be more of a problem for technology-based sectors.[73] Peng, Zucker, and Darby discovered that rural industry in China experienced strong productivity and growth rates, although proximity to cities and education levels play a significant role in the transfer of embodied technology by urban dwellers.[74]

The lessons for innovation in Atlantic Canada are twofold. First, the relatively small size of its urban centres is problematic, although it may be alleviated through the tighter economic integration of cities and their surrounding areas as well as by networking between cities in the region. Cities that function as a tight urban system can achieve the economies of scale, infrastructural improvements, and innovative synergies that dispersed cities of 35,000 or 350,000 cannot. Second, tighter integration of the Atlantic urban system helps achieve

---

69. Hanson, *Scale Economies*.

70. Black and Henderson, "A Theory of Urban Growth"; Glaeser, "Learning in Cities."

71. D. Costa and M. Kahn, *Power Couples: Changes in the Locational Choice of the College Educated, 1940–1990* (Cambridge, MA: National Bureau of Economic Research, 1997), Working Paper 7109.

72. Easterly and Levine, "What Have We Learned?"

73. D. Smallborne and D. North, "Innovation and New Technology in Rural Small- and Medium-Sized Enterprises: Some Policy Issues," *Environment and Planning C: Government and Policy* 17(5) (1999): 549–66.

74. Y. Peng, L. Zucker, and M. Darby, *Chinese Rural Industrial Productivity and Urban Spillovers* (Cambridge, MA: National Bureau of Economic Research, 1997), Working Paper 6202.

effects of scale, but they remain only partial if not accompanied by stronger integration with large, innovative metropolitan areas such as Montreal, Toronto, Boston, or New York. Defining the fine line between infra-regional competition and parochialism remains a difficult challenge.

Localized Spillovers and Agglomeration

The proximity of firms to one another and to research institutions helps create synergies through the interactions of skilled researchers, workers, entrepreneurs, and supporting institutions. Interactions can produce positive externalities known as *knowledge spillovers*. How spillovers are actually produced is debated between those who support a market perspective of sufficient incentives for entrepreneurial scientists and technicians (e.g., patents and licensing agreements) and those who take a broader view of supporting regional institutions, routines, and norms (e.g., trust, corporate and entrepreneurial cultures, risk aversion). It becomes important to understand the roles of cities as accumulators of human capital and knowledge, as places that encourage diversity and favour creativity.

The more knowledge and skills that are embodied in individuals, the more likely it is that the spillovers will be localized. Innovative regions become economically successful regions when they develop a sustained ability to produce and commercialize flows of innovative technologies. Research and training facilities are essential, but firms and regions must be equally good at fostering networks with the outside world, since the sum of knowledge and innovations produced abroad far exceeds what can be produced locally. Moreover, learning can never be reduced to acquiring formal skills. There is enormous benefit to be derived from learning by doing (experience) and from learning by interacting; both based on what suppliers or competitors do and on recognizing and incorporating the knowledge, skills, and ideas of workers that extend beyond their required tasks.

Coupling local expertise and potential with the production of localized knowledge has become the target of innovation strategies. Generating spillovers and overcoming deficiencies of scale are best achieved through collaborations involving firms as well as government departments, government labs, and academia. An important element of regional innovation policy is the decentralization of federal R & D labs together with SSHRC and NSERC centres of excellence. Given the economic benefits associated with spillovers emanating from federally funded research centres, regional equity demands a

geographical distribution based on population rather than a concentration within a few select regions. Such decentralization needs to reflect a region's competitive advantages so as to avoid the squandering of resources. Centres of excellence devoted to aquaculture seem particularly appropriate for the region, while others, such as the one on e-commerce, are potentially beneficial, provided that collaborative rather than parochial approaches are pursued.

Are Resources a Curse?

Is resource dependence problematic for the Atlantic Canadian economy? There is a debate currently as to whether resource-based economies are prone to slower growth.[75] As argued previously in this chapter, innovation is not limited to high-tech sectors. Development agencies have too often made attracting high-tech firms a cornerstone of their innovation policies, diverting resources from traditional sectors and limiting potential gains by increasing value-adding production in existing industries such as forestry and fisheries. The challenge is finding a balance between regional specialization and industrial diversification instead of focusing on fashionable industries.

The principal aim throughout this chapter has been to lay the economic and geographic bases supporting regional innovation strategies. I have tried to strike a note of caution with respect to the growing number of policies and strategies that have come to embrace innovation without having a proper concern for its numerous dimensions, sources, and implications. I have also argued that a broader conception of innovation allows for a better understanding of its relationship to knowledge and learning. Competing models of economic growth theorize about the role of knowledge and innovation. They help increase productivity when markets and preferences are assumed to be constant, but they may hold greater implications when markets are seen as evolving. We are increasingly recognizing the diversity of sources and indicators by which innovations can be fostered and measured. Smaller regions like the Atlantic provinces face additional challenges in terms of scale, urbanization, and immigration.

---

75. J. Sachs and A. Warner, *Natural Resource Abundance and Economic Growth* (Cambridge, MA: Harvard Institute for International Development, 1995), Development Discussion Paper no. 517a; O. Manzano and R. Rigobon, *Resource Curse or Debt Overhang?* (Cambridge, MA: National Bureau of Economic Research, 2001), Working Paper 8390.

Part 2

A Statistical Analysis of Innovation in Atlantic Canada

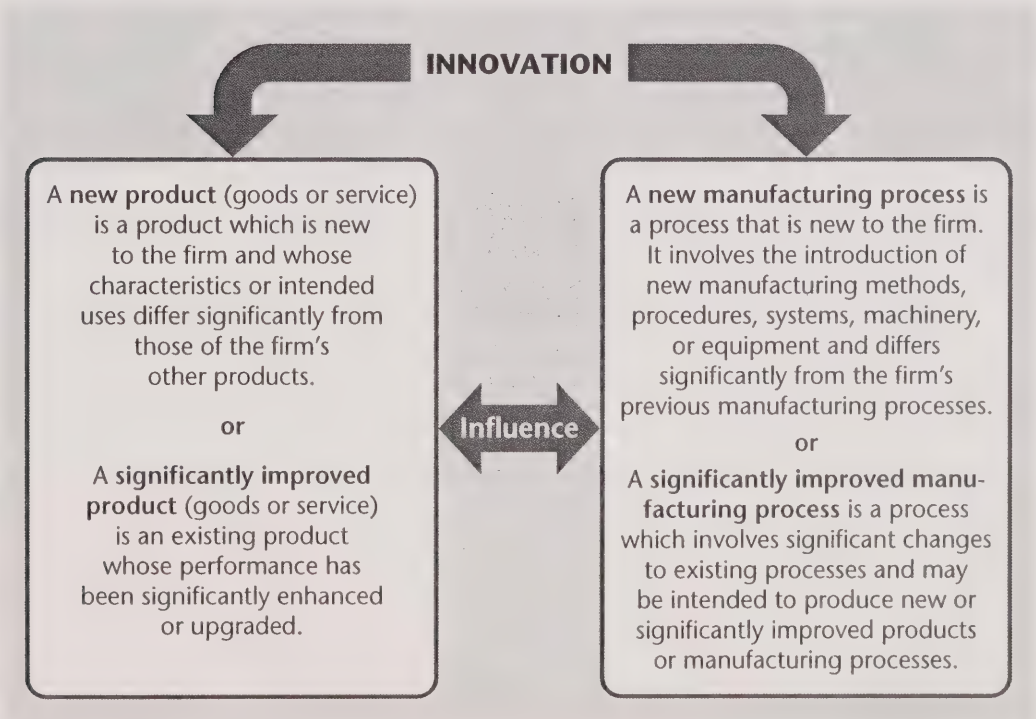
Samuel LeBlanc

Background

As shown in part 1, innovation has many aspects that are both complex and difficult to quantify. In part 2, we use the definition of *innovation* that was adopted by Statistics Canada's *1999 Survey of Innovation*, as this is our main source of information. This definition is outlined in figure 1. The term innovation as used here is limited to cases where new products or processes are developed or marketed. It could therefore be said that a company is innovative if it has developed or marketed a new or significantly improved product or process.

Figure 1

Definition of Innovation



Source: From Statistics Canada *1999 Survey of Innovation* (Ottawa: Statistics Canada, 2001). Special Order; designed by Samuel LeBlanc.

Innovation in Atlantic Canada's manufacturing industry is examined in part 2 and is based on the definition in figure 1. In this part of the study, we take an empirical approach to the subject of innovation.

To put our analysis in its proper context, we start by drawing an overall picture of the state of innovation in Atlantic Canada. Chapter 2 reviews the data from the *1999 Workplace and Employee Survey* (WES), which revealed a surprisingly high innovation rate among the region's firms. Our analysis is then extended to include the four following factors, which are all innovation indicators: the tendency to integrate new technologies, research and development (R & D), copyrighting of new products or processes, and the importance given to training. Each of these factors helps us put this initial innovation rate in a more specific context.

With the overall context established, we focus in chapter 3 on the manufacturing industry, a success story in innovation. Using data from the *1999 Survey of Innovation*, a more detailed study is made of the role of innovation in this industry in Atlantic Canada, which in 1999 included 1,635 firms and 110,700 employees, i.e., in both cases about 5 percent of the industry at the national level.[1] As chapter 3 indicates, the region's manufacturing firms are doing very well in the race to innovate when compared to the country as a whole. The role of nine distinct impacts on innovation is then examined. As this chapter shows, the effects of innovation go far beyond a simple increase in profits. They also result in the opening up of new markets and help firms improve their productivity and increase their ability to adjust to the requirements of their clients.

Clearly, innovations do not happen overnight. Aware of the extent of innovation in Atlantic Canada, we look in chapter 4 at the innovation efforts of firms. To get a proper measure of these efforts, the many sources of information consulted during the innovation process are first examined, after which innovators and firms as a whole are compared with respect to three basic innovation-related activities. The course of our examination thus leads us to consider two important activities that promote innovation in Atlantic Canada: collaboration and the use of government programs. We also study the numerous obstacles faced by innovators in their work. High costs, research and development difficulties, lack of skilled labour — these problems, and

1. Statistics Canada, *Manufacturing Industries of Canada: Subprovincial Areas, 1999* (Ottawa: Statistics Canada, 2002). Special Order; Statistics Canada, *Historical Labour Force Statistics, 2000* (Ottawa: Statistics Canada, 2001).

many more have individually or collectively jeopardized a number of innovation projects. By identifying them, we hope to better understand the innovation network that has been established in the region and how it might grow even more.

Chapter 2

The Atlantic Provinces: At the Heart or on the Fringe of Innovation?

Whether innovation, and the higher profits that accompany it, derives from the introduction of a new product or from improved processes resulting in lower production costs, it is a way for a business to ensure a high degree of competitiveness in a border-free, dynamic, and often very competitive economy. Commenting on the contribution of innovative firms to the economy, a Conference Board of Canada report says: "Innovation is a key driver of productivity gains and long-term economic growth. A nation's socio-economic performance is increasingly determined by its innovation performance."[2] The authors of the report further add that Canada is progressively falling behind in the race to innovate, while traditionally less competitive nations, such as Ireland, India, and Denmark, are taking over new markets.[3] It is important, therefore, to determine the place of Atlantic Canada's firms in the world of innovation.

A High Degree of Innovation — with Qualifications

Before surveys such as the WES were used to collect data on innovation rates per se, a large number of indicators tried in their own way to define the phenomenon of innovation. These indicators are still useful today not only because they are valuable as tools for verifying innovation rates, but also because they provide additional information about the phenomenon itself. It will be seen that according to the WES data, innovation rates are particularly high in Atlantic Canada firms. Following is an attempt to better understand these rates using four conventional innovation indicators.

Our starting point is the 1999 WES data (the data were collected by Statistics Canada). Unique in Canada, this survey tried to identify the recent trends created by the impact of new technologies, innovation, and changes in the workplace. Covered in the survey were a total of 6,351 firms and 24,597 employees throughout Canada, representing

2. Conference Board of Canada, *Building the Future: 1st Annual Innovation Report* (Ottawa, 1999), iii.
3. Ibid., 3.

0.86 and 0.23 percent respectively of each category of the sectors surveyed. The survey was only for the year 1999. As for the industries examined, the survey extended to fourteen sectors of the economy, thus covering a large part of the economic activity in Canada.[4]

The first set of data we looked at concerned the innovation rate by region. As can be seen from table 1, the Atlantic region ranked second in Canada, with 51.1 percent of firms reporting a product or process innovation in 1999. The region therefore exceeds the Canadian average by 3 percentage points. These numbers are rather surprising given some of the studies on the subject in the Atlantic region. In particular, Charles McMillan stated in his study on Atlantic Canada's new economy that the innovation gap would be the biggest challenge the region would have to face if unemployment were to be eliminated.[5] Likewise, the Atlantic Canada Opportunities Agency (ACOA) suggested in a framework paper on innovation that "the region's innovation network is not as developed as in other regions."[6] Given such statements, caution must be exercised when considering these WES numbers.

When the types of innovations are examined more closely, it appears that firms in the Atlantic region are above the national average with respect to "Products Only" and "Processes Only," with rates of 19.7 and 4.0 percent respectively. However, most firms that innovated did so in both products and processes. In this regard, Atlantic Canada firms are still in second place, with an innovation rate of about 27 percent. They are outranked only by Ontario firms, which have a 34 percent rate.

Atlantic Canada firms can thus be commended for their fine performance in the field of innovation. But since the accuracy of these numbers is of some concern, let us try to better define their scope.

---

4. Statistics Canada, *Workplace and Employee Survey,* Compendium (Ottawa: Department of Industry, 2001), 46–47. This document provides detailed information on the survey's methodology. With regard to the survey population, "WES draws its sample from the Business Register (BR) maintained by the Business Register Division of Statistics Canada, and from lists of employees provided by the surveyed employers." As for the sampling plan, "Prior to sample selection, the business locations on the frame were stratified into relatively homogeneous groups.... The WES frame was stratified by industry (14), region (6), and size (3), which was defined using estimated employment.... The sample was selected using Neyman allocation.... The frame for the employee component of WES was based on lists of employees made available to the interviewers by the selected workplaces.... Interviewers in person collected the workplace survey data.... For the employee component, telephone interviews were conducted with persons who had agreed to participate in the survey."

5. C. McMillan, *Focusing on the Future: The New Atlantic Revolution* (Halifax: Council of Atlantic Premiers, 2001), iv.

6. ACOA, *Atlantic Innovation Fund: Framework Paper,* www.acoa.ca/e/financial/aif/framework.html (consulted 20 February 2002).

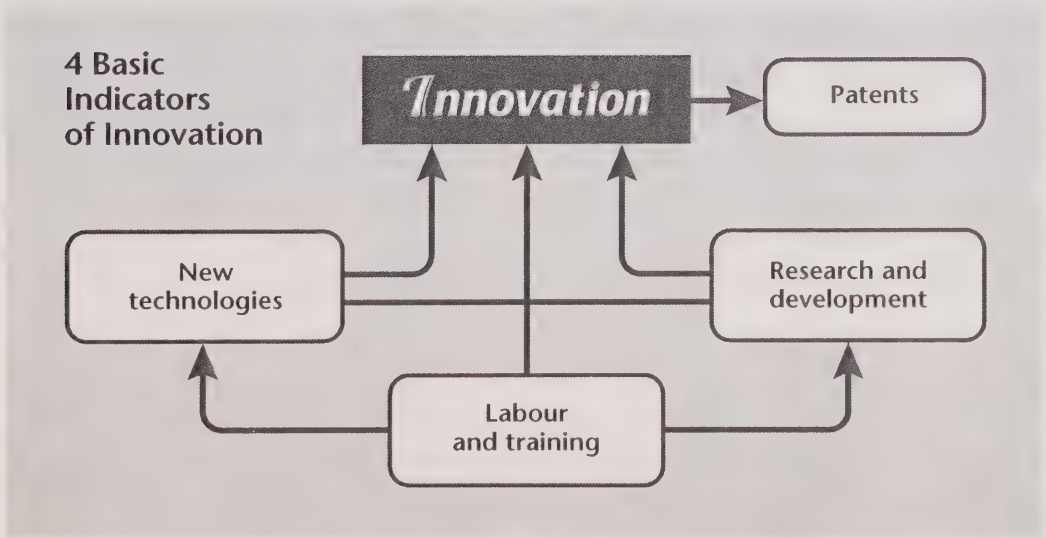
Table 1

Percentage of Innovative Firms in Canada, by Region (14-Industry Average), 1999

	Innovative Firms	Type of Innovation by Firm: Products Only	Processes Only	Products and Processes	Estimated Number of Firms (Innovative + Non-innovative)	Proportion of Innovative Firms in Canada
Canada	48.1	16.2	3.5	28.4	735,911	100.0
Ontario	53.0	15.0	4.0	34.0	276,920	37.6
Atlantic Canada	51.1	19.7	4.0	27.1	63,152	8.6
Manitoba	46.7	21.4	0.8	24.5	27,888	3.8
British Columbia	46.0	17.0	4.1	25.0	105,279	14.3
Quebec	45.2	18.7	3.0	23.5	153,277	20.8
Saskatchewan	43.4	12.2	5.2	26.0	29,333	4.0
Alberta	39.6	12.0	1.7	25.9	80,063	10.9

Sources: Statistics Canada, *1999 Workplace and Employee Survey* (Ottawa: Statistics Canada, 2001). Special Order; *Workplace and Employee Survey*, Compendium (Ottawa: Department of Industry, 2001); compiled by Samuel LeBlanc.

Four basic indicators of innovation are used to place these WES data in their proper context and to help provide a better understanding of innovation. They are (a) new-technology use, (b) number of patents issued, (c) research and development, and (d) degree of staff training. The relationship between these indicators is shown in the following graph.



New Technologies

The integration of new technologies is the first conventional indicator of a potential for innovation. According to Porter, new technologies "can create new possibilities for the design of a product, the way it is marketed, produced, or delivered, and the ancillary services provided. It is the most common precursor of strategic innovation."[7] There should therefore be a positive correlation between the integration level of new technologies and the number of innovations reported.

However, the WES data indicate the opposite in the Atlantic provinces. In 1999, 20.2 percent of the region's firms implemented a new computer application, 3.5 percent used computer-assisted new technologies, and 3.4 percent introduced some other type of technology or machine. In addition to being low, these rates of new-technology integration are all below the national levels, i.e., 24.0, 4.0, and 4.0 percent respectively. That is why firms in the Atlantic region are second to last in both technology implementation and innovation, since only 14 percent have introduced a new technology and developed a new product or process. That puts them over 3 percentage points under the national average (see table 2). Although new-technology use and workplace computerization are not the only factors that promote innovation, they are among the most important. In this regard, firms in Atlantic Canada are not doing very well.

The WES data on new-technology integration revealed other very interesting facts. In particular, more than a third (36.5 percent) of Atlantic Canada firms have innovated without implementing new technologies, which is the highest rate in the country. The challenge is to determine how these firms were able to innovate without resorting to new technologies. One possible explanation is that these firms, being unable to afford new technologies, made a greater or different use of the instruments available to them in order to innovate. Otherwise, the road to innovating products or processes, without resorting to new technologies, involves the use of new materials. Unfortunately, no information was collected on this in the WES or in any of the other surveys of innovation consulted.

If these data indicated that Atlantic Canada firms make little use of new technologies, the *1996 Survey of Innovation*, which dealt with dynamic services, suggested that the region's firms were, to some extent, able to integrate them more. Dynamic services include three types of new-technology-producing firms, which, by their inherent

7. M. Porter, *The Competitive Advantage of Nations* (New York: Free Press, 1990), 45–46.

Table 2

Percentage of Firms in Canada Integrating New Technologies and Innovating, by Region (14-Industry Average), 1999

	Implementation of New Technologies[a] and Innovation	Innovation with No Implementation of New Technologies	Implementation of New Technologies Without Innovation	No Implementation of New Technologies or Innovation
Canada	17.5	30.6	8.2	43.7
Ontario	20.1	32.9	8.0	39.0
Alberta	18.2	21.4	8.7	51.8
Quebec	16.4	28.7	8.2	46.6
Saskatchewan	15.9	27.5	14.0	42.6
British Columbia	15.4	30.6	8.0	46.0
Atlantic Canada	14.2	36.5	7.6	41.6
Manitoba	13.0	33.7	4.2	49.1

Source: Statistics Canada, *Workplace and Employee Survey*, Compendium (Ottawa: Department of Industry, 2001); compiled by Samuel LeBlanc.

[a] Namely, computer applications, computer-assisted technologies, and other technologies or machinery.

nature, are often precursors of innovation. These firms are computer services, engineering consultant services, and other scientific and technical services. The impact of the diffusion of dynamic services is such that the other sectors of the economy adopt many of their innovations.[8] Thus, the degree of innovation in dynamic services should be transmitted to the other industrial sectors.

According to the *1996 Survey of Innovation*, such firms in Atlantic Canada have innovation rates that are near the national average. Indeed, 55 percent of the region's computer services firms were innovative, whereas engineering consultant services and other scientific and technical services had an innovation rate of 34 percent each. A comparison with the national averages (56, 41, and 35 percent respectively) indicates that the gaps between the two sets of figures are minimal.[9]

8. J. Baldwin et al., *Innovation in Dynamic Service Industries* (Ottawa: Statistics Canada, 1998), 22.

9. Data from Statistics Canada *1996 Survey of Innovation* (Ottawa: Statistics Canada, 2001). Special Order.

In light of these numbers, it is important to realize that Atlantic Canada firms could make greater use of the new technologies provided by the dynamic services industry — and even of those provided by the region's firms.

Research and Development

Closely related to technological surges and innovation, R & D is the activity through which new ideas emerge and grow, with some being transformed into new products and processes. To measure the relationship between R & D and innovation, the Organization for Economic Co-operation and Development (OECD) suggested that two types of data be retained: the financial and human resources allocated to R & D.[10] As will be seen, Atlantic Canada firms are faced with severe problems concerning the availability of resources when compared with the country as a whole, a fact which can only harm their quest to innovate.

With respect to R & D expenditures,[11] the private and public sectors injected $517 million into the Atlantic region in 1998, which represents 3.4 percent of all such expenditures at the national level. Together, the provinces of Ontario and Quebec accounted for 74 percent of R & D expenditures, i.e., over $11 billion. R & D expenditures from commercial firms alone amounted to only $94 million in Atlantic Canada in 1998, which is 1.1 percent of the total Canadian expenditures. Beyond the generally low level of expenditures in the Atlantic provinces, the national trend was fairly stable from 1995 to 1998. This shows that relative to the WES, there were no massive investments in R & D in Atlantic Canada prior to the survey, which could explain the surprisingly high innovation rate in the region.

The same disparity exists with R & D staff. In 1998 the Atlantic provinces had 1.7 percent (1,265 workers) of all those involved in R & D in Canada, placing them last among the provinces. At the other end of the spectrum, Ontario and Quebec had 83.4 percent of the manpower in this area: 63,757 workers.[12]

---

10. OECD, *Science, Technology, and Industry Outlook, 2000* (Paris: OECD, 2001), 28.

11. Statistics Canada, *Estimates of Canadian Research and Development Expenditures (GERD): Canada, 1989 to 2000, and by Province, 1989 to 1998* (Ottawa: Statistics Canada, 2001); compiled by Samuel LeBlanc.

12. Statistics Canada, *Industrial Research amd Development: Intentions 2000* (Ottawa: Statistics Canada, 2001), 33, table 2.4.

Although R & D may not be the sole engine of innovation, the fact remains that efforts in this area by Atlantic Canada firms betray a certain lack of dynamism, and most probably a shortage of resources. Moreover, since firms have such limited funds for conducting R & D, the region suffers a significant loss which can seriously jeopardize its economic development. Indeed, according to the OECD, "The link between R & D and national income has strengthened over time; the coefficient of correlation between R & D expenditures per capita and GDP per capita has increased from almost 0.7 in 1985 to 0.8 in 1998."[13]

Issuance of Patents

Frequently associated with innovation, the issuing of patents is a third indicator of innovative activity.[14] According to data from the Canadian Intellectual Property Office (CIPO), patenting activity in the four Atlantic provinces is minimal compared with that in the country as a whole. In fact, in 1999 the Atlantic region accounted for only 2.8 percent of all patents in Canada, the same proportion as in 1998. For their part, Ontario and Quebec had close to 75 percent of the patents issued in Canada in 1999.[15] Though the disparity is striking, it is subject to two qualifications. First, the use of patents can be an ineffective protection mechanism owing to excessively high costs or to the nature of the invention, as in the case of a process. Second, Baldwin, Hanel, and Sabourin noted that some researchers strictly limit their use of patents to certain sectors such as the chemical or the pharmaceutical industry.[16] In other words, the significance of patents should be regarded as only relative.

Nevertheless, the Atlantic provinces' poor performance in obtaining patents indicates that there is room for improvement. That is not to say, however, that there is a nearly complete lack of innovation in the region.

---

13. OECD, *Science, Technology, and Industry Outlook, 2000*, 28.

14. M. Trajtenberg, *Is Canada Missing the "Technology Boat"? Evidence from Patent Data* (Ottawa: Industry Canada, 2000), 3. Trajtenberg defines the nature of patents as follows: "A patent is a temporary monopoly awarded to inventors for the commercial use of a newly invented device. For a patent to be granted, the innovation must be non-trivial, meaning that it would not appear obvious to a skilled practitioner of the relevant technology, and it must be useful, meaning that it has potential commercial value."

15. Canadian Intellectual Property Office (CIPO), 2001, special order.

16. J. Baldwin, P. Hanel, and D. Sabourin, *Determinants of Innovative Activity in Canadian Manufacturing Firms: The Role of Intellectual Property Rights* (Ottawa: Statistics Canada, 2000), 8.

Labour's Contribution

The last factor affecting innovation is labour. Whatever its nature, degree of originality, and benefits, an innovation is created by individuals. In his study *Innovation, Training, and Success*, Baldwin stressed this point when he said, "Innovation may be a key to success, but advanced worker skills are often seen to be essential to innovation."[17]

In this regard, the WES provides some very interesting data. Indeed, close to 64 percent of employees in Canada are directly or indirectly involved with innovation in their work environment, compared with close to 60 percent in Atlantic Canada. Paradoxically, the WES also reveals that more than half (55 percent) of workplaces in Canada do not train their employees. In Atlantic Canada, the numbers are even higher: two-thirds (66 percent) of firms give their employees no formal training at all.

And yet if there is one factor that has become significant over the last few years with respect to a firm's performance, it is the need to have highly skilled workers. According to the OECD, good training must include lifelong learning. In addition, workers must be creative, know how to work in teams, and have cognitive skills in economies which are increasingly based on innovation and technological change.[18] In this connection, the 45 percent of employees in Canada and the 35 percent of those in Atlantic Canada who receive some training are generally indicative of how little employers respond to these requirements (see table 3).

A recent study by Beaudin and Breau, *Employment, Skills, and the Knowledge Economy in Atlantic Canada*, brings this labour analysis into sharper focus on two levels. As explained by these researchers, the tendency of firms to train their employees is largely determined by the industrial structure of the region. Thus, "The lower participation rate [in training activities] in the Atlantic provinces undoubtedly reflects the fact that their economic structure is based more on the primary and secondary sectors than is the case elsewhere in the country."[19] Beaudin and Breau reject the argument that the high cost of training is an insurmountable obstacle in a region with a high concentration

17. J. Baldwin, *Innovation, Training, and Success* (Ottawa: Statistics Canada, 1999), 5.

18. OECD, *A New Economy? The Changing Role of Innovation and Information Technology in Growth* (Paris: OECD, 2000), 45.

19. M. Beaudin and S. Breau, *Employment, Skills, and the Knowledge Economy in Atlantic Canada* (Moncton: Canadian Institute for Research on Regional Development, 2001), 122.

Table 3

Percentage of Firms in Canada and Atlantic Canada Training Their Employees (14-Industry Average), 1999

		General Training				
	No Training	Orientation of New Employees	Training in Supervision and Management	Training in Sales and Marketing	Health and Safety	Other
Canada	55	29	11	11	1	4
Atlantic Canada	66	22	6	9[a]	9	2[a]

	Innovation-Related Training				
	Computer Equipment	Computer Software	Team- and Leadership-Building Techniques	Occupational Training	Apprenticeship Training
Canada	10	19	11	9	9
Atlantic Canada	9[a]	16[a]	9[a]	6	4

Source: Statistics Canada, *1999 Workplace and Employee Survey* (Ottawa: Statistics Canada, 2001). Special Order; compiled by Samuel LeBlanc.

[a] These numbers have a high coefficient of variation and should be interpreted with caution.

of small- to medium-size firms. Indeed, "A review of labour force distribution according to firm size in Atlantic Canada reveals that almost 62 percent of jobs in 1995 were in medium- to large-sized firms, compared with only 59 percent in Canada."[20]

These observations suggest a lack of commitment by Atlantic Canada firms to train their employees. Since the availability of skilled labour is crucial to the innovation process, the lack of training is undoubtedly detrimental to the economy and to innovative activity in the Atlantic provinces.

Innovation by Industrial Sector

Thus far, we have tried to give a general overview of the state of innovation in Atlantic Canada. For a clearer picture of the subject, it is important to see in which industries innovation is most prevalent and in which it is less. At the same time, we will explain why special attention is given to the manufacturing sector, a leader in innovation.

20. Ibid.

Figures 2 and 3 show the 1999 distribution of innovation within industries in Canada and Atlantic Canada. Overall, it appears that the industries most innovatively active are manufacturing, finance, and insurance. In Canada, innovation rates of 55 percent were reported in primary and secondary manufacturing, of 61 percent in tertiary labour-intensive manufacturing, and of 72 percent in tertiary capital-intensive manufacturing. In the finance and insurance industries, 62 percent of firms reported some product and process innovation.

In Atlantic Canada, the situation is similar though more balanced. For instance, the primary-manufacturing sector has an innovation rate of only 35 percent, which is clearly lower than in the country as a whole. This is a problem that should be examined in the region, given its dependency on primary resources. It is in the secondary-manufacturing, labour-intensive-manufacturing, and capital-intensive-manufacturing sectors that innovation is the most evident in the Atlantic region. According to the WES, 58, 68, and 54 percent of firms in these sectors respectively are innovative. The same innovative dynamism is also found in the finance and insurance sector, where 68 percent of firms introduce a new product or process.

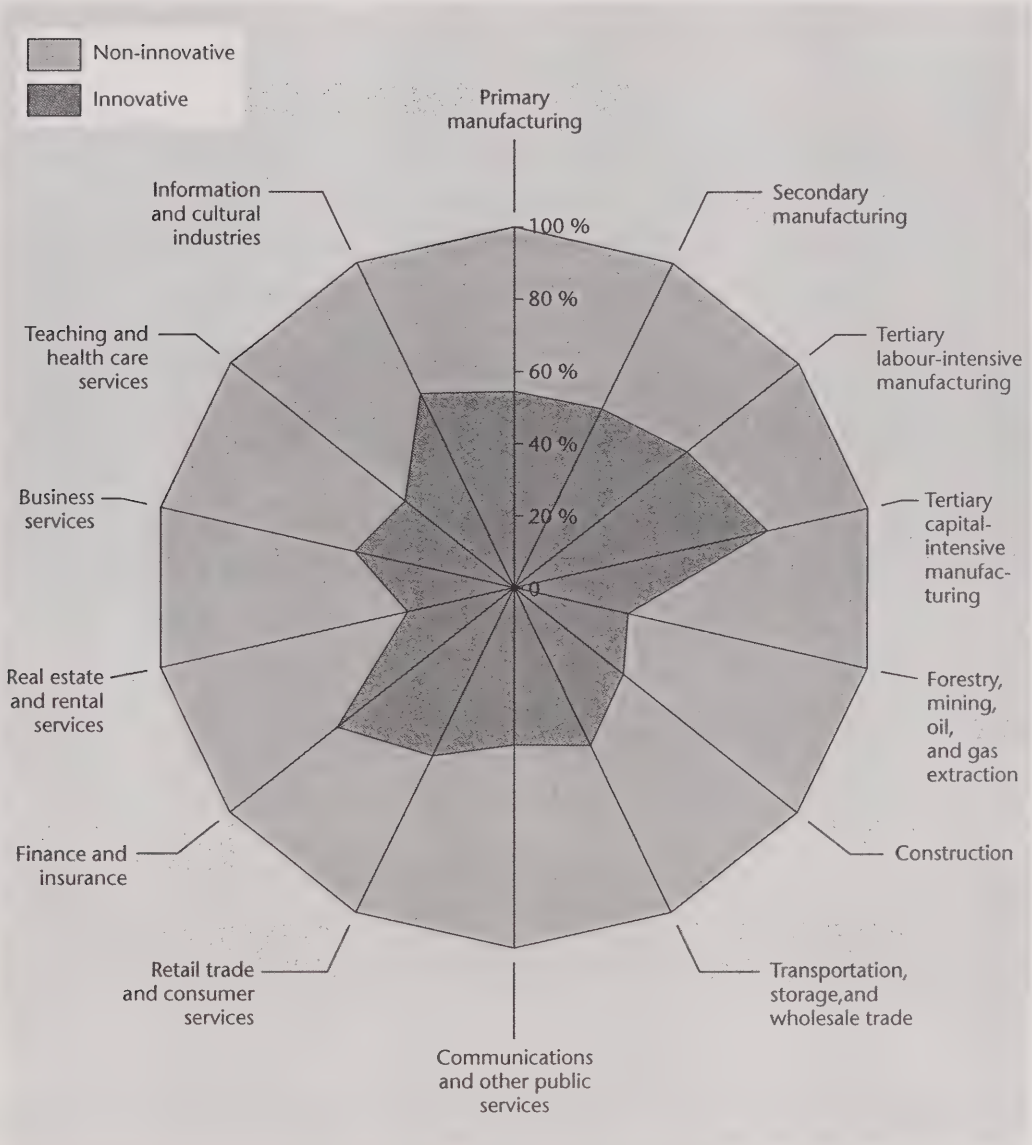
The least innovative sectors are construction and real estate and rental services, which rank last with innovation rates of 39 and 30 percent respectively in Canada, and 31 and 37 percent respectively in Atlantic Canada. In the six other major industrial sectors, the proportion of innovative firms varies from 40 to 60 percent both in Canada and Atlantic Canada. These last numbers prove that innovation is not solely confined to high-technology industries.

It has been noted that 60 percent of workers are affected by innovation. According to the WES (see figure 4), in Canada and Atlantic Canada the largest proportion are concentrated in the manufacturing and the finance and insurance sectors. In the Atlantic provinces, 52 percent of employees in the tertiary labour-intensive-manufacturing sector, 61 percent of those in the primary-manufacturing sector, 80 percent of those in the secondary-manufacturing sector, and 58 percent of those in the tertiary capital-intensive manufacturing sector have been affected by an innovation. And in the finance and insurance sector, the proportion is 82 percent.

Given that such a high proportion of workers are to be found in industries where innovation is most active in the region, it is difficult to underestimate the value of a highly skilled labour force with access to constant training.

Figure 2

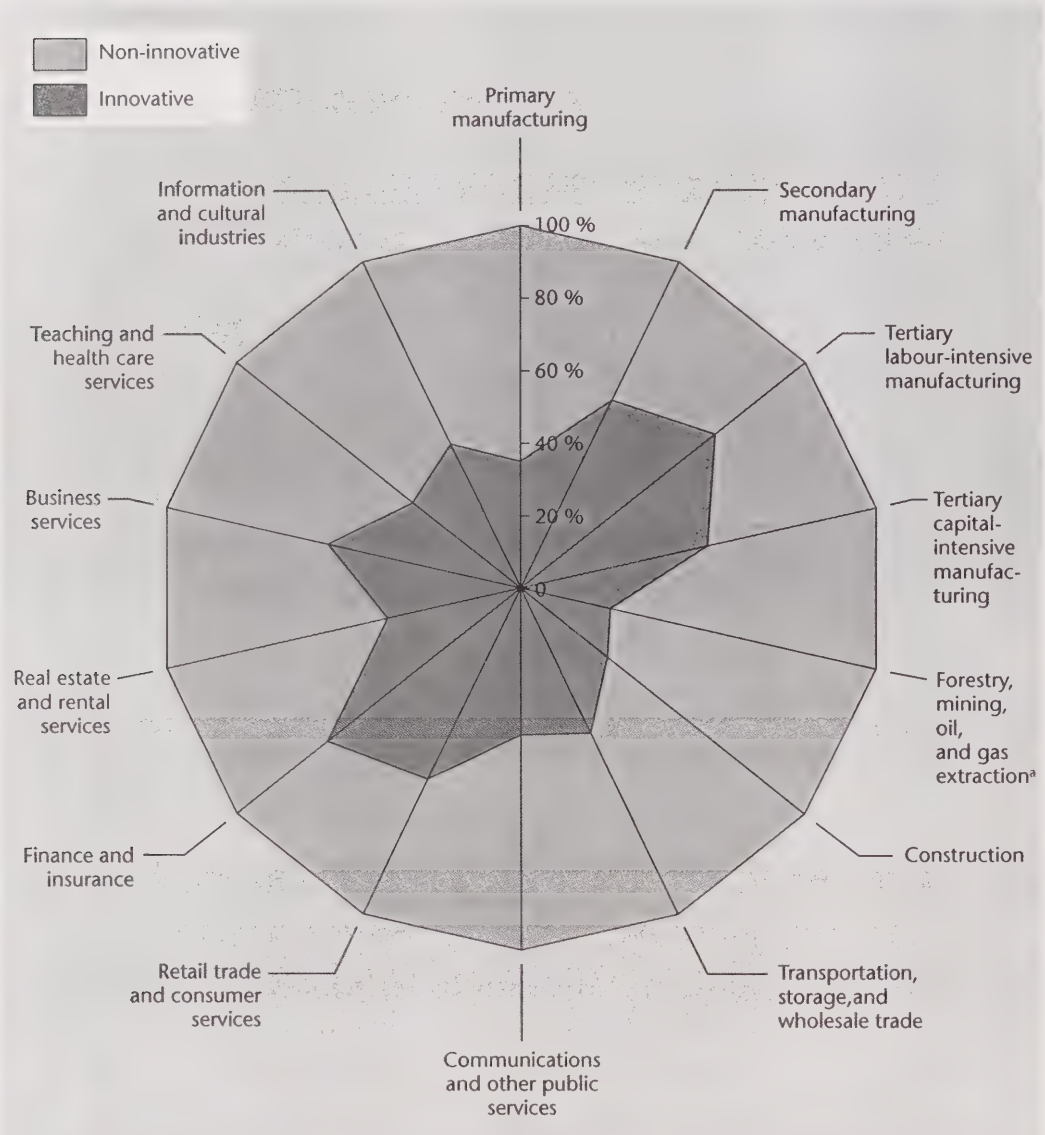
Percentage of Innovative and Non-innovative Firms in Canada, by Industry, 1999



Source: Statistics Canada, *1999 Workplace and Employee Survey* (Ottawa: Statistics Canada, 2001). Special Order; compiled by Samuel LeBlanc.

Figure 3

Percentage of Innovative and Non-innovative Firms in Atlantic Canada, by Industry, 1999

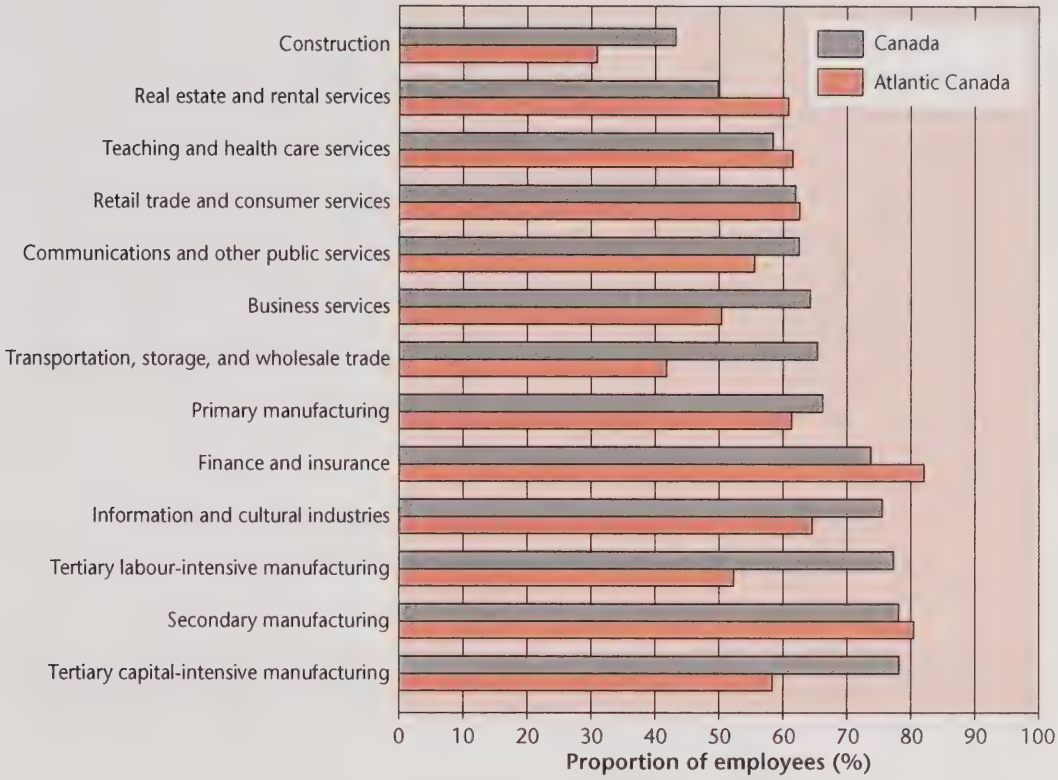


Source: Statistics Canada, *1999 Workplace and Employee Survey* (Ottawa: Statistics Canada, 2001). Special Order; compiled by Samuel LeBlanc.

[a] These numbers have a high coefficient of variation and should be interpreted with caution.

Figure 4

Percentage of Employees Working in an Innovative Environment in Canada and Atlantic Canada, by Industry, 1999



Source: Statistics Canada, *1999 Workplace and Employee Survey* (Ottawa: Statistics Canada, 2001). Special Order; compiled by Samuel LeBlanc.

Although there is a tendency to associate innovation strictly with high-technology and knowledge-intensive industries, the data from the last three figures suggest not only that a very wide range of firms are innovating in order to remain competitive, but also that a large number of them are responding to the call. Nevertheless, one should wonder about the quality of those innovations, as they are not all equal.

Innovation: A Matter of Originality

Now that we have a quantitative measure of innovation in Atlantic Canada, we will try to study the phenomenon from a qualitative perspective. Our intention is to determine what proportion of innovations are firsts at the international, national, local, or in-house levels. These distinctions will enable us to evaluate their degree of originality. Up to now, all innovations have been considered in the same way: a new or significantly improved product or process recently introduced

within the firm. However, being the first to use a new product or process has economic benefits which vary according to the originality of the product or process. It may lead to a monopoly, which benefits the innovative firm (e.g., higher profits, more efficient and rapid production) until a competitor replicates it.

As indicated by table 4, Atlantic Canada firms closely follow the national average with respect to the originality of their innovations. Surprisingly, both in Atlantic Canada and in Canada, 1.0 percent of firms report a worldwide innovation. The main difference is in the distribution of new products and processes at the national and local levels. Atlantic Canada firms have a greater tendency to concentrate their efforts on the local market, so that their innovations have a low degree of originality. Finally, with respect to in-house firsts, Atlantic Canada firms are just as numerous as those in Canada.

Table 4

Distribution (%) of Innovative Firms in Canada and Atlantic Canada According to the Originality of Their Main Innovation (14-Industry Average), 1999

	World First	Canadian First	Local-Market First	In-House First	Don't Know
Canada	1.0	3.0	7.0	37.0	52.0
Atlantic Canada	1.0	1.6	11.0[a]	37.3	49.1

Source: Statistics Canada, *1999 Workplace and Employee Survey* (Ottawa: Statistics Canada, 2001). Special Order; compiled by Samuel LeBlanc.

[a] This number has a high coefficient of variation and should be interpreted with caution.

To qualify this analysis, it should be emphasized that part of the reality is ignored by grading these innovations only in terms of their originality, as this approach fails to consider the needs of either the firm or the region. Although it is advisable to encourage firsts at the world level for the above-mentioned reasons, the efforts of Atlantic Canada firms must not be condemned for being more imitators than precursors.

As the preceding analysis shows, we are trying to meet a big challenge by seeking to determine if firms in the Atlantic region are at the heart or on the fringe of innovation. We took the WES data as our starting point since this survey dealt with fourteen industries throughout Canada and looked in particular at innovation. After being surprised by the fact that more than half of Atlantic Canada

firms had introduced a new product or process in 1999, thereby ranking the region second in the country, we wished to make our analysis more specific in light of four basic innovation indicators. In doing so, we realized that the Atlantic region is neither at the heart nor on the fringe of innovation, but somewhere in between.

Several questions remain to be addressed, in particular regarding the economic benefits of innovation, which are so often spoken of. However, due to the complexity of the subject matter and the extent of the industries, it is only by concentrating on innovation in a specific sector that we will be able to find answers to these and many other questions. To this end, the manufacturing industry seems well suited to such an analysis.

Chapter 3

The Dynamics of Innovation in Atlantic Canada

The federal government recently launched its innovation strategy, *Achieving Excellence: Investing in People, Knowledge, and Opportunity*, thereby announcing the upcoming challenges for the Canadian economy. According to this document, "Canada's innovation performance is improving at a quick pace, and we enjoy the fastest rate of growth in some areas."[1] The government recognizes that without the regions' active participation, the foundation of Canada's innovation system would be fragile — the reason being that "a paradox of the global, knowledge based economy is that sources of competitive advantage tend to be localised.... It is in communities that the elements of the national innovation system come together."[2] And so it is from this dual perspective — sectoral and regional analysis — that we now intend to look at the degree to which the Atlantic region's manufacturing firms contribute to the race to innovate.

Based on the general analysis of the state of innovation in Atlantic Canada, carried out in the previous chapter, we will see that the region's manufacturing firms compare favourably with those of the rest of the country. In fact in most cases their success reveals a relentlessness which bears fruit in many ways. That said, let us see how the *1999 Survey of Innovation* allowed us to arrive at these conclusions.

The *1999 Survey of Innovation*

Fourth of its kind for the manufacturing industry, the *1999 Survey of Innovation* followed those of 1989, 1993, and 1998. While these latter surveys centred around the introduction of advanced technologies in the manufacturing industry, the 1999 survey focused on innovation. Because of the nearly complete absence of disaggregation at the provincial level in the three former surveys, the data used here have been taken almost exclusively from the 1999 survey. This constraint posed

1. Canada, *Achieving Excellence: Investing in People, Knowledge, and Opportunity* (Ottawa: Industry Canada, 2001), 12.
2. Ibid., 72.

no major problems since the *1999 Survey of Innovation* was spread out over three years, from 1997 to 1999.[3] With 5,455 respondents from all thirty-one subsectors of the manufacturing industry, i.e., a representation rate of 17 percent, the survey is a rich source of information.[4]

It should be emphasized, however, that the survey imposed a limit which prevents a full understanding of the innovation phenomenon in the manufacturing industry. Concerned with the need "to reduce response burden,"[5] firms with less than twenty employees were excluded from the 1999 survey, even though *The Oslo Manual* recommended the opposite.[6] As a result, 3,765 manufacturing firms from Atlantic Canada were excluded from the survey (i.e., 48 percent of the overall industry, according to a conservative estimate),[7] including a portion of the industry which might be important to the region if Porter was right when he said: "Companies that innovate are frequently not established leaders, or even large companies, for many of these reasons. Any economies of scale in R & D that would favor large firms are outweighed by the fact that many innovations do not involve complicated technology, and large firms face many barriers to perceiving and acting on discontinuities."[8]

---

3. See S. Schaan and F. Anderson, *Innovation in Canadian Manufacturing: Provincial Estimates* (Ottawa: Statistics Canada, 2001). The survey's methodology is explained on pages 19–20: "The target population was all firms in the manufacturing sectors (NAICS 31-33) (North American Industry Classification System, Statistics Canada, 1998) or in selected natural resource industries (NAICS 1133, 212, 2211).... The target population was based on a list of firms compiled from respondents to existing production surveys conducted by Manufacturing, Construction and Energy Division (MCED) at Statistics Canada.... The sampling unit was neither at the enterprise nor the establishment level, but rather, it was a grouping (or cluster) of establishments. Within each province for each enterprise, all establishments of the same NAICS 4-digit code were grouped to form one sampling unit or 'provincial enterprise.' .... The sample was randomly drawn from the population of provincial enterprises stratified by province.... Questionnaires were mailed out with mail, telephone and fax follow ups carried out for non respondents.... The overall response rate for the survey for manufacturing industries was 95%, for a total of 5,455 completed questionnaires."
4. This calculation is based on the manufacturing firms in Canada as surveyed in the following documents: Statistics Canada, *Manufacturing Industries of Canada: Subprovincial Areas, 1999* (Ottawa: Statistics Canada, 2002). Special Order; Schaan and Anderson, *Innovation in Canadian Manufacturing*. As explained below, however, given that the *1999 Survey of Innovation* excluded firms with less than twenty employees and that there is no equivalent disaggregation in the figures reported in *Manufacturing Industries of Canada*, the representation rate given is slightly lower than it should be.
5. Schaan and Anderson, *Innovation in Canadian Manufacturing*, 19.
6. OECD, *The Measurement of Scientific and Technological Activities: Proposed Guidelines for Collecting and Interpreting Technological Innovation Data — The Oslo Manual* (Paris, 1996), 45.
7. This calculation is based on the *Business Register* (2001), from which we excluded firms with less than twenty employees so that it corresponded to the *1999 Survey of Innovation*.
8. M. Porter, *Competitive Advantage of Nations* (New York: Free Press, 1990), 49.

This deficiency aside, the *1999 Survey of Innovation* has considerable depth both in sampling and in issues addressed, and is therefore very reliable as regards the conclusions that can be drawn from it.

Innovation in the Manufacturing Industry

If the WES data provided a glimpse of the good innovation performance of manufacturing firms, data from the *1999 Survey of Innovation* seemed to highlight it even more. Table 1 shows that 80 percent of Canadian manufacturing firms innovated between 1997 and 1999, with 68 percent of them developing a new or significantly improved product. Moreover, if we go outside the usual comparison framework between Canada and the United States, it can be seen that Canadian firms are doing quite well. Mohnen and Therrien reported that according to the *1997–1998 European Community Survey of Innovations* (comparable to the *1999 Survey of Innovation*), 30 percent of manufacturing firms in Spain were innovative, while in France, Germany, and Ireland, the proportions of innovative firms were 44, 68, and 74 percent respectively.[9] Clearly, Canadian manufacturing firms are indeed very innovative. But what about their performance at the provincial level?

A closer examination of table 1 reveals that almost all manufacturing firms actively participate in the innovation process. The small gap between innovation rates, which vary from 73 to 83 percent by province, indicates a very competitive environment, in which innovation is close to 76 percent, just below the national average of 80 percent — a mere 4-percentage-point difference. By breaking down these innovation rates, it can be seen that the region's firms are close to the national average with respect to innovations in products only and in processes only, with rates of 14.3 and 12.8 percent respectively, compared to 14.4 and 12.3 percent in Canada. In contrast, there is a real gap between firms that innovated in both products and processes: 48.8 percent in Atlantic Canada and 53.3 percent in Canada. Overall, Prince Edward Island, Nova Scotia, and Newfoundland and Labrador rank in third, fourth, and fifth with innovation rates of 79.7, 77.1, and 76.6 percent respectively. New Brunswick lags behind in eighth place with 73.9 percent, which is still a very good performance.

---

9. P. Mohnen and P. Therrien, *How Innovative Are Canadian Firms Compared to Some European Firms? A Comparative Look at Survey of Innovations* (MERIT, Maastricht [Holland]: Infonomics Research Memorandum Series, 2001), 23.

Table 1

Percentage of Innovative and Non-innovative Manufacturing Firms in Canada, by Province, 1997–99

		Type of Innovation			Number of Manufacturing Firms in 1999[a]	Proportion of Innovative Firms in Canada
	Innovative Firms	Products Only	Processes Only	Products and Processes		
Canada	80.2	14.4	12.3	53.3	29,784	100.0
Atlantic Canada	75.9	14.3	12.8	48.8	1,635	5.5
Ontario	83.1	13.3	13.4	56.3	11,647	39.1
Quebec	82.3	14.5	11.1	56.7	8,738	29.3
Prince Edward Island	79.7	10.2	10.3	59.2	143	0.5
Newfoundland and Labrador	77.1	11.9	18.1	47.2	260	0.9
Nova Scotia	76.6	13.8	12.7	50.0	634	2.1
Saskatchewan	74.3	15.1	9.6	49.6	698	2.3
British Columbia	74.2	17.1	13.3	43.7	3,615	12.1
New Brunswick	73.9	12.6	15.5	45.8	598	2.0
Alberta	73.8	15.7	11.3	46.7	2,481	8.3
Manitoba	73.3	16.0	10.6	46.8	970	3.3

Source: Statistics Canada, *1999 Survey of Innovation* (Ottawa: Statistics Canada, 2001). Special Order; Statistics Canada, *Manufacturing Industries of Canada: Subprovincial areas, 1999* (Ottawa: Statistics Canada, 2002). Special Order; compiled by Samuel LeBlanc.

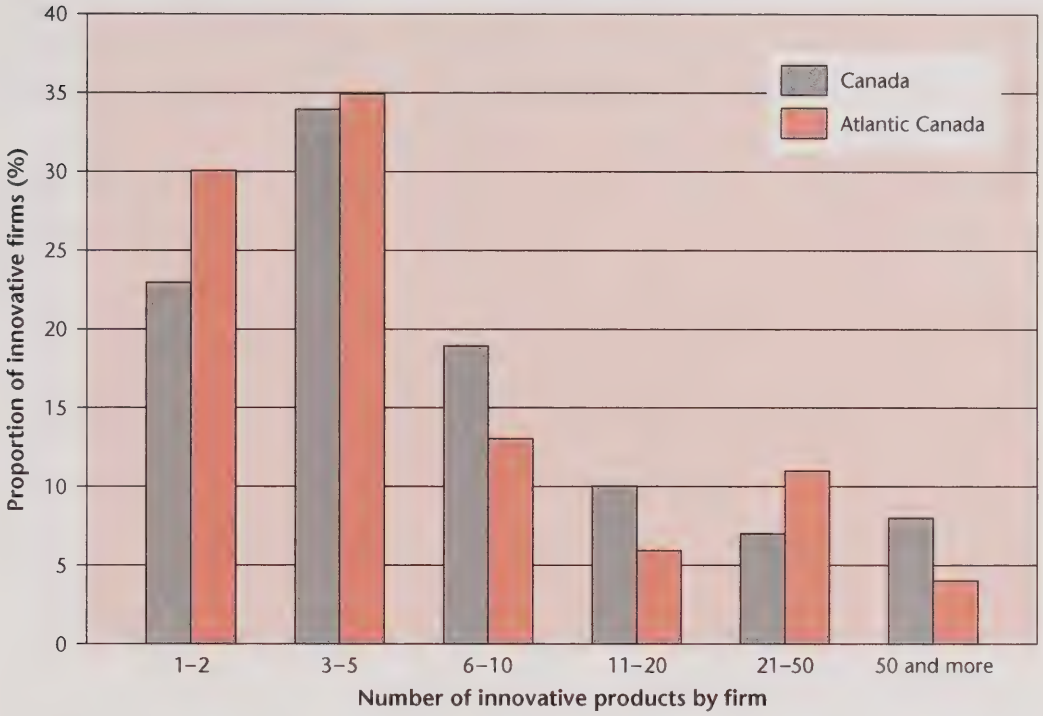
[a] This is the sum of innovative and non-innovative firms. It should be noted that these numbers overestimate the population considered in the *1999 Survey of Innovation*, as we were unable to exclude firms with less than twenty employees.

At this point in our analysis, it could almost be said that the state of innovation in the Atlantic provinces is characterized most by its omnipresence. Also, the consistency of innovation rates among the Atlantic provinces shows that the region's firms provide their fair share of innovations at the national level and are also doing well at the international level.

In spite of all these percentages, we are still some way from fully appreciating innovation in the Atlantic region. A second comparison can be made using the data from figure 1, which combines innovative manufacturing firms in terms of the number of new or significantly improved products introduced between 1997 and 1999.

Figure 1

Distribution (%) of Innovative Manufacturing Firms in Canada and Atlantic Canada According to the Number of Innovative Products Introduced, 1997–99



Source: Statistics Canada, *1999 Survey of Innovation* (Ottawa: Statistics Canada, 2001). Special Order; compiled by Samuel LeBlanc.

Not surprisingly, a majority of Atlantic Canada firms (65 percent) introduced from one to five innovations, although a fair number (11 percent) had from twenty-one to fifty innovations. In this regard, the Atlantic region exceeds the national average by 4 percentage points. However, firms that reported fifty innovations or more are twice as numerous in Canada (8 percent) as in Atlantic Canada (4 percent). In absolute terms, a conservative estimate of 7,317 innovations were introduced in Atlantic Canada between 1997 and 1999.[10]

The distribution of innovative manufacturing firms in each of the Atlantic provinces follows the national trend, with the majority of firms introducing from one to five innovations. However, there are small groups of firms in Atlantic Canada that are distinguishing themselves: in Nova Scotia and New Brunswick, 13 and 14 percent of firms

10. This calculation is based on the *Business Register* (2001), from which we excluded firms with less than twenty employees so that it corresponded to the *1999 Survey of Innovation*. In addition, so as not to overestimate the number of innovations, we used the lower number in the interval of new or significantly improved products.

respectively have introduced from twenty-one to fifty innovations, while in Prince Edward Island, close to 15 percent have reported more than fifty new products, an astonishing performance.

In short, this brief analysis places Atlantic Canada's manufacturing firms very close to the leaders in innovation. Three-quarters of them have reported one or more innovations, with the range seeming to be equally divided between new products and new processes, which is the same as for Canadian firms as a whole.

Now to better define the nature and extent of these innovations, we will integrate the data on (a) the originality of innovations and (b) their distribution within the manufacturing industry.

Atlantic Canada Manufacturers: World-Class Innovators

It will be remembered that the WES data indicated that Atlantic Canada firms tended to copy innovations rather than introduce new products or processes that were world firsts. In the case of manufacturing firms, however, their share of world firsts is clearly more impressive, both in Atlantic Canada (9 percent) and in the country as a whole (12 percent). Nevertheless, it should be emphasized that the WES covered only one year, while the *1999 Survey of Innovation* was spread out over three years.

Table 2

Distribution (%) of Innovative Manufacturing Firms in Canada and Atlantic Canada According to the Degree of Originality of Their Main Innovation, 1997–99

	World First[a]	Canadian First[a]	In-House First[a]
Canada	12.0	32.0	83.0
Atlantic Canada	9.0	26.0	80.0
New Brunswick	4.9	19.0	76.6
Prince Edward Island	16.6	47.0	93.3
Nova Scotia	13.0	31.2	78.8
Newfoundland and Labrador	4.2	15.3	82.4

Source: Statistics Canada, *1999 Survey of Innovation* (Ottawa: Statistics Canada, 2001). Special Order; compiled by Samuel LeBlanc.

[a] To correctly interpret these data, it must be understood that a world first is also a Canadian and an in-house first. If the innovation is not a world first but a Canadian first, it is also an in-house first. That is why the total for the three innovation categories exceeds 100 percent. As a result, the proportion of innovations at the national and in-house levels must be somewhat reduced.

In spite of these enviable results, there is a similar trend between firms in general and manufacturing firms in that a large majority assimilate the innovations that surround them. This approach can prove successful for a while, but when a firm replicates innovations, it is only catching up with its competitors. These firms must therefore stay alert, always aware that other innovations are about to burst on the scene.

Among the Atlantic provinces manufacturing firms, those from Prince Edward Island are setting an example to be emulated. According to the 1999 survey, close to 17 percent of innovations in Prince Edward Island firms and 13 percent of those in Nova Scotia firms were world firsts, which is higher than the national average. The gap only widens when considering the Canadian firsts that have occurred in Prince Edward Island: 47 percent of innovations launched in that province were Canadian firsts, which is 15 percent higher than the national average. In Nova Scotia, the number of firms with a Canadian first hovers around the national average. However, in the provinces of Newfoundland and Labrador and New Brunswick there is reason for concern, as the number of firms that have developed world-class innovations is about a third of the national average: 4.2 and 4.9 percent of firms respectively, compared with the national average of 12 percent. The same disparity exists with respect to national firsts in innovation: 15 percent of firms in Newfoundland and Labrador and 19 percent in New Brunswick, compared with 32 percent nationally.

Finally, the situation of the Atlantic provinces' manufacturers with regard to the originality of their innovations is very respectable when compared to the situation in Spain, France, Germany, and Ireland. Indeed 11 percent of Spanish firms introduced innovations that were firsts nationally or internationally, while the proportion was 21 percent in France, 25 percent in Germany, and 27 percent in Ireland.[11]

Sectoral Analysis of Innovators

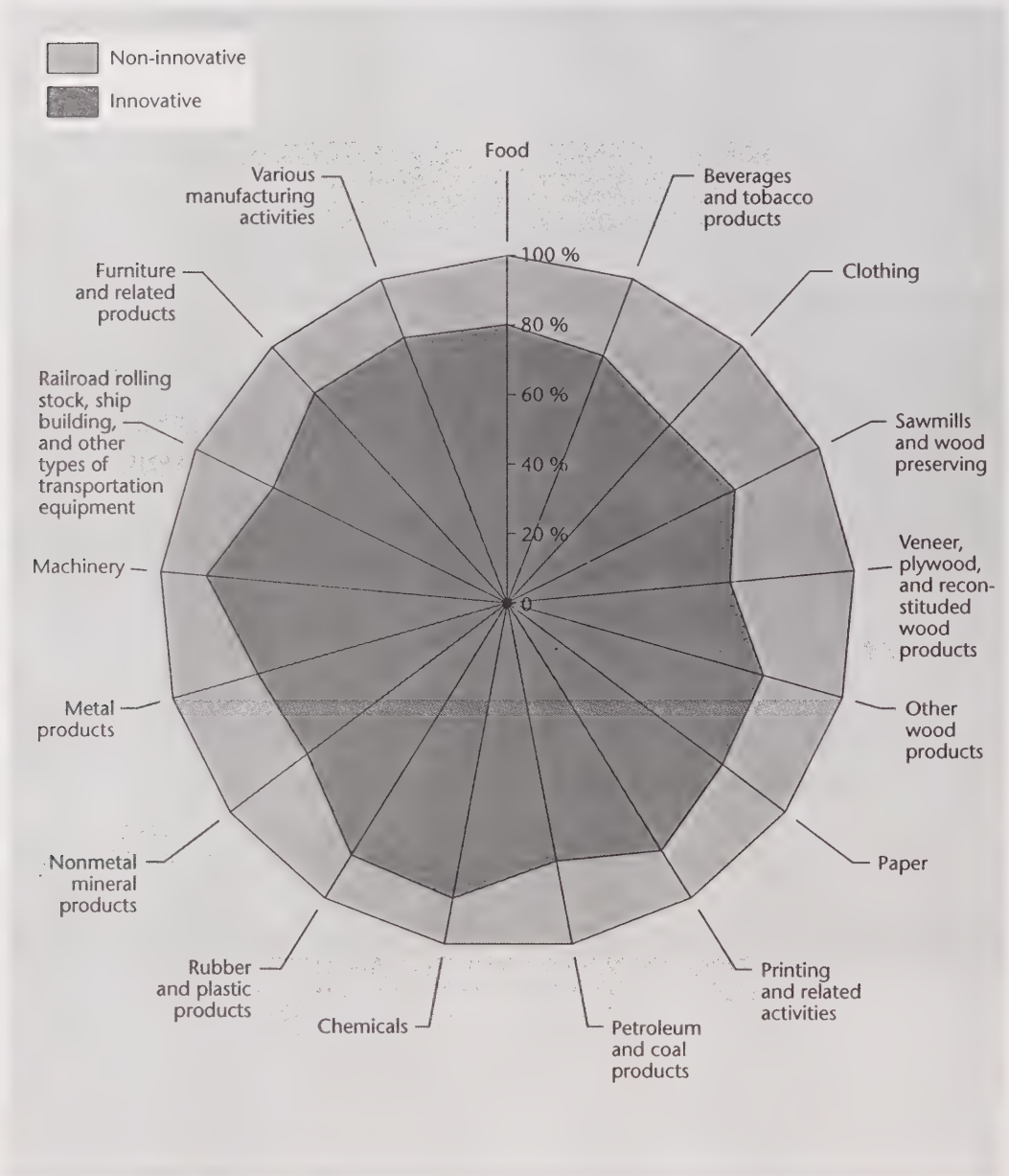
Having examined the originality of innovations, the significance of the innovation rates for the manufacturing industry as a whole will now be considered in greater depth (see table 1). This industry, which has so far been addressed in general terms, includes an impressive variety of subsectors.[12] Although it would be preferable to study each

11. Mohnen and Therrien, *How Innovative Are Canadian Firms?*, 25.

12. At the highest degree of precision, there are 259 subsectors, according to the five-digit North American Industry Classification System (NAICS). In the *1999 Survey of Innovation*, the number of subsectors was reduced to 31.

Figure 2

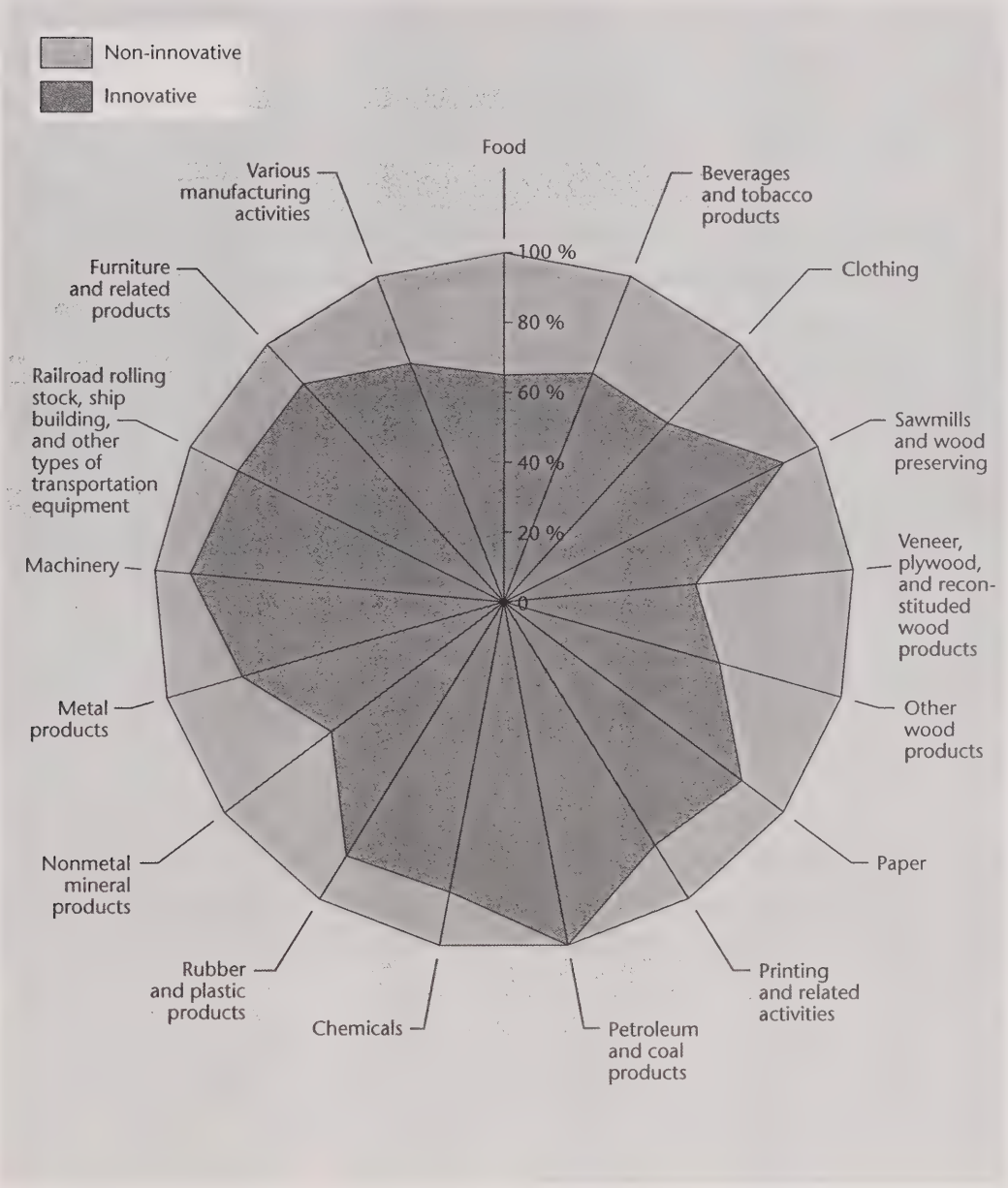
Percentage of Innovative and Non-innovative Manufacturing Firms in Canada, 1997–99



Source: Statistics Canada, *1999 Survey of Innovation* (Ottawa: Statistics Canada, 2001). Special Order; compiled by Samuel LeBlanc.

Figure 3

Percentage of Innovative and Non-innovative Manufacturing Firms in Atlantic Canada, 1997–99



Source: Statistics Canada, *1999 Survey of Innovation* (Ottawa: Statistics Canada, 2001). Special Order; compiled by Samuel LeBlanc.

one separately, our analysis was limited by two constraints: the issue of confidentiality, which prevented us from collecting certain innovation rates, and the fact that some coefficients of variation were too high at the subsectoral level, which produced unreliable data. Figures 2 and 3 depict a selection of subsectors that although weak in scope are strong in certainty.

We know that 80 percent of Canada's firms are innovative, however, figure 2 shows where the industry's strengths lie. At the top of the list is the manufacturing of chemicals,[13] where close to 88 percent of firms reported having introduced an innovation which proved to be a world first in 15 percent of the cases. This is followed by the manufacturing of machinery, where 87 percent of firms reported an innovation, of which 16.3 percent were world firsts, and then the manufacturing of rubber and plastic products, which had an 86 percent innovation rate and 14.6 percent of the firms producing world firsts.

At the other end of the spectrum, the lowest innovation rate (65 percent) is in the veneer, plywood, and reconstituted-wood-products sector. Although there are fewer innovative firms in this sector, those that do innovate distinguish themselves by the originality of their innovations, which were world firsts in 19.3 percent of the cases — one of the highest rates observed.

It goes without saying that the innovation rates presented in figure 2 are relatively consistent throughout the manufacturing sectors, as these are national averages. It is by looking at innovation rates by province, in particular in the Atlantic region, that nuances appear which reflect structural differences within the industry.

First among innovators in Atlantic Canada (see figure 3) are firms that manufacture petroleum and coal products, with an innovation rate of 100 percent. Then comes the machinery-manufacturing sector, which accounts for 90 percent of innovative firms, of which 28 percent[14] achieved a world first. Third is the sawmill and wood-preserving industry, where 90 percent of firms are innovative. Paradoxically, in spite of this high innovation rate, none of these firms has had a world or even a Canadian first.

---

13. There are other more innovative sectors in Canada which were not included in the graph because there were no equivalents for the Atlantic provinces. These were the manufacturing of semiconductors and other electronic components, 95 percent; computer and peripheral equipment manufacturing, 96 percent; and audio and video equipment manufacturing, 100 percent.

14. This number is doubtful as it has a high coefficient of variation.

Among the sectors that lag behind, there is once again the veneer, plywood, and reconstituted-wood-products sector, with an innovation rate of 55 percent. It is followed closely by the nonmetal-mineral-products industry, which has 62 percent of innovative firms, of which 11 percent still had a world-class innovation. It should be emphasized that the *1999 Survey of Innovation* data do not allow a clearer picture at the provincial level because they are subject to rules of confidentiality and have coefficients of variation that are too high at the provincial level. We therefore had to limit ourselves to the Atlantic region.

By using the same analytical structure as in chapter 2, we tried to get a better understanding of the innovation phenomenon through empirical data relating to the region's manufacturing firms. As a rule, Atlantic Canada firms, with an innovation rate in the order of 76 percent, are doing just as well as those in the rest of the country, or in the four European countries considered. In addition, with respect to the originality of their innovations, it is clear that innovators in Atlantic Canada are able to hold their own at the international level when compared to their counterparts in the other provinces.

Now that the scope of the innovation phenomenon within the regional manufacturing industry is better understood, the time has come to look at the many benefits of innovation — benefits that are beyond the reach of non-innovators.

Benefits of Innovation for Manufacturing Firms

It is generally understood that innovation and technological change are powerful agents of economic growth. As emphasized by the OECD, however, "It is difficult to capture their contribution in empirical analysis."[15] And yet that is precisely the goal of this section, in which the effects of the development of new products and processes will be examined.

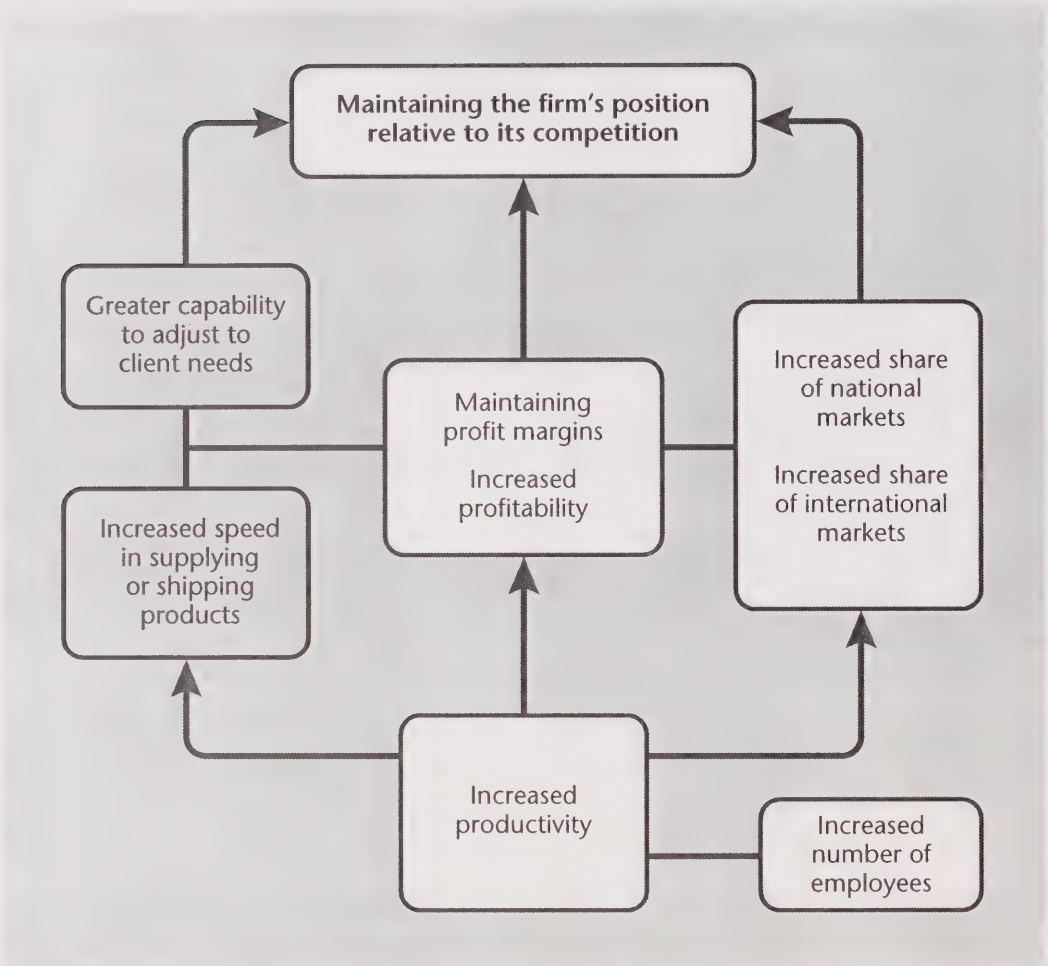
The *1999 Survey of Innovation* will prove essential in guiding our analysis, since the entrepreneurs who responded to it evaluated the importance of the many impacts of innovation according to an intensity scale. It must be emphasized, however, that these data are of a subjective nature. Consequently, we need to detach ourselves from the phenomena as much as possible (which is facilitated by additional data), as the importance ascribed to a specific impact is not necessarily the same for one innovator as for another.

---

15. OECD, *A New Economy? The Changing Role of Innovation and Information Technology in Growth* (Paris: OECD, 2000), 27.

Figure 4

Innovation's Nine Impacts on Innovative Firms in the Manufacturing Sector



Source: Based on the *1999 Survey of Innovation* (Ottawa: Statistics Canada, 2001). Special Order; designed by Samuel LeBlanc.

The nine impacts identified in the 1999 survey are summarized in figure 4, which also shows the relationship between them. By no means comprehensive, these impacts nevertheless include the basic consequences of innovation within the firm. In addition, the respondents gave a significant value to each impact. Let us now look at the main impacts of innovation on the firm — from the most general one, maintaining the firm's position, to the intermediate ones, and finally to those felt at the base, on productivity and the number of jobs. These empirical data will enable us to identify the reasons that motivate entrepreneurs to innovate.

Maintaining Position Relative to the Competition

The first impact, "maintaining the firm's position relative to its competition," partially summarizes the cumulative effect of innovation on the firm. In other words, adjusting to client needs, increased productivity, increased market share, etc., all work together to ensure that the innovative firm is able to keep its place in relation to its competitors.

In this regard, the *1999 Survey of Innovation* reported that approximately one-third of firms in Canada (35 percent) and in Atlantic Canada (33 percent) "strongly agree" that maintaining their position is an important impact of innovation. At the provincial level there are slight differences, the proportion of firms which give as much weight to this impact varying between 27 percent in Newfoundland and Labrador and 36 percent in Nova Scotia.

Even if there is some consensus on the importance of innovation in maintaining a firm's position, consideration must also be given to firms that hold the opposite point of view — that is, those who assigned little or no importance to this impact. There are two reasons why they might take this view. First, some innovators have been able to *get ahead* of their competition thanks to an innovation, so what they are opposed to is the idea of simply *maintaining* their position relative to the competition. Second, a firm may be unable even to keep pace with its rivals because the innovation in question has not produced the expected results.

Generally, the responses to this first impact of innovation, which stems from its other effects, indicate that a significant number of firms innovate and compete in this manner. Innovation is thus fundamental to any firm that wishes to stay ahead of the competition or even simply to keep on producing. As Porter points out: "The fear of loss often proves more powerful than the hope of gain."[16]

Greater Capability in Responding to Demand

Behind the observation that innovation generates a "greater capability to adjust to client needs" is one of the fundamental laws of economics: the law of supply and demand. Innovation meets the needs of the client. There was some consistency in how innovators assessed the importance of this impact: according to the *1999 Survey of Innovation*, about a quarter of firms (24 percent in Canada and 27 percent in Atlantic Canada) considered this as a major impact.

---

16. Porter, *Competitive Advantage of Nations*, 49.

The form that this response to demand can take is easier to see in light of four goals actively sought by entrepreneurs (see table 3). Among these goals are additional data on the success rate of efforts to increase the speed of delivery of products. According to the *1999 Survey of Innovation*, 17 percent of innovators in Canada claimed that their innovations allowed them to reach that goal, compared to 19 percent of those in the Atlantic region. In this latter group, only the firms from Newfoundland and Labrador set themselves apart, with 27 percent stating that they were able to increase their speed of delivery. This gap can be explained by the greater distance to market for firms in that province.

Table 3

Goals Set by Manufacturing Firms in Canada and Atlantic Canada to Meet Client Demand, 1997–99

	Percentage of Firms Stating This Goal Is "Very Important"					
	Canada	Atlantic Canada	Newfound-land and Labrador	Prince Edward Island	Nova Scotia	New Brunswick
Improved quality of products	54	56	78	49	50	55
Expanded product range	47	42	42	48	43	41
Faster delivery of products to market	42	35	34	29	32	40
Reduced environmental damage	16	19	18	12	20	19

Source: Statistics Canada, *1999 Survey of Innovation* (Ottawa: Statistics Canada, 2001). Special Order; compiled by Samuel LeBlanc.

Although the goal to better meet client needs is no more than one would expect, its importance will be highlighted in the analysis of the problems and obstacles faced by firms. Apparently, a surprising proportion of innovations do not satisfy client expectations.

Increased Profitability

In addition to improving a firm's competitiveness and client satisfaction, innovation can also have financial benefits. For an overall picture, we refer back to the WES data on the revenues of firms from

fourteen industries across Canada and the Atlantic provinces. These data indicate that innovative firms experience a growth in revenues more often than firms that do not innovate. It is interesting to note that in Atlantic Canada, innovative firms are more likely to see a growth in revenues (30 percent) than they are at the national level (25 percent). What is more interesting, however, is that in spite of the risks associated with innovation, innovative firms more often than non-innovative firms tend to be among those with increasing rather than decreasing revenues. In other words, because the number of innovative and non-innovative firms with decreasing revenues in Canada and Atlantic Canada is almost equal, and fewer innovative (about 13 percent) than non-innovative (about 20 percent) firms report stable revenues, this allows for a stronger link between innovation and the economic benefits it generates.

Table 4

Impact of Innovation on Revenues of Firms in Canada and Atlantic Canada (14-Industry Average), 1999

	Percentage of Innovative Firms Whose Revenues Are			Percentage of Non-innovative Firms Whose Revenues Are		
	Increasing	Stable	Decreasing	Increasing	Stable	Decreasing
Canada	25	14	10	22	20	9
Atlantic Canada	30	13	8	20	21	8

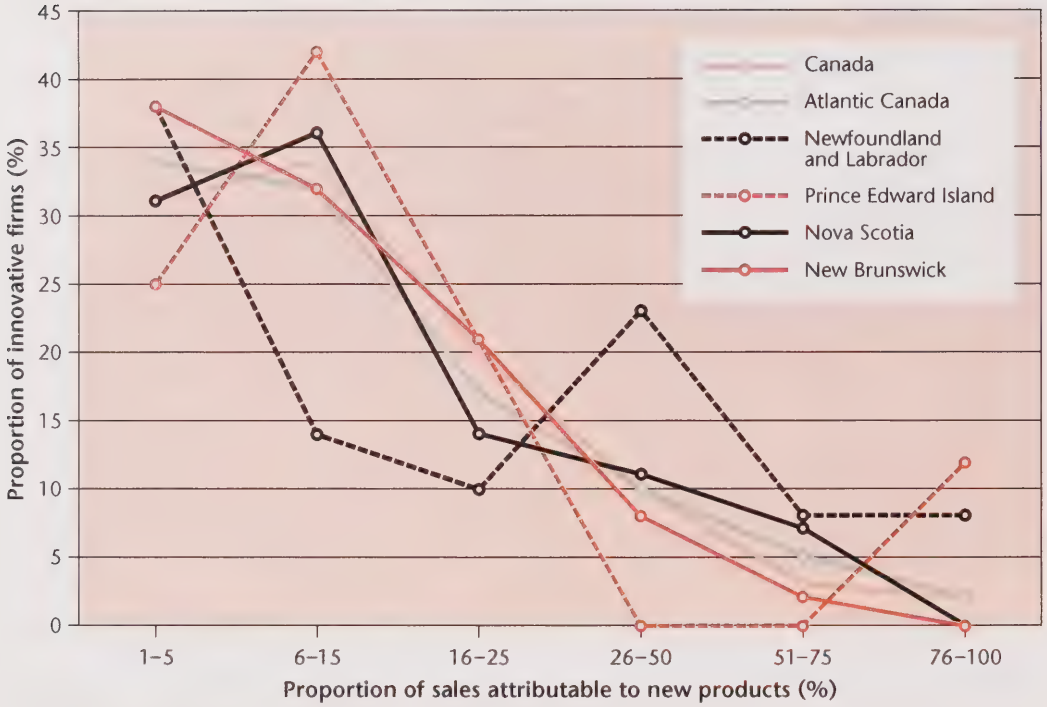
Source: Statistics Canada, *1999 Workplace and Employee Survey* (Ottawa: Statistics Canada, 2001). Special Order; compiled by Samuel LeBlanc.

Although it is tempting to correlate innovation with the increased revenues reported by the WES, the fact is that there is no empirical evidence to support such a relationship. It is also true that a multitude of factors other than innovation may explain such increases. Nevertheless, by using the data from the *1999 Survey of Innovation*, we can establish a certain correlation (see table 4). According to this survey, 22 percent of Canadian innovators believe that innovation has very important effects on their "increased profitability" and "increased profit margins." In Atlantic Canada, the proportion of firms to credit these effects is slightly higher than the Canadian average — 25 and 26 percent respectively (with no marked differences between provinces). These numbers not only show the existence of financial gains in the manufacturing sector that are associated with innovation; they also reinforce the correlation between innovation and increased revenues, as suggested by the WES data.

In addition to the respondents' subjective assessments, sales figures are another indication of the financial impact of innovation. However, since the commercial aspect of process innovations is difficult to track, sales from innovations will only be applied here to new or significantly improved products. As indicated in figure 5, a large majority of firms in Canada (65 percent) and in Atlantic Canada (66 percent) reported that their new products represented from one to 15 percent of their sales.

Figure 5

Percentage of Sales Attributable to New Products of Innovative Firms in Canada and Atlantic Canada, 1997–99



Source: Statistics Canada, *1999 Survey of Innovation* (Ottawa: Statistics Canada, 2001). Special Order; compiled by Samuel LeBlanc.

Newfoundland and Labrador is an exception, with 38 percent of its firms clustered in the interval of one to 5 percent of sales and another 23 percent in the interval of 26 to 50 percent of sales. In addition, some firms from Newfoundland and Labrador (8 percent) and Prince Edward Island (12 percent) indicated that all their sales were attributable to innovations (these are firms created as a result of their innovations).

Generally, these figures show the expected benefits from innovations in products, while at the same time explaining how innovations can contribute to a firm's profitability and increase its profit margin.

Conquering New Markets

Although innovation is often a response to the demands of existing clients, there is always the hope that it will attract new ones. This is supported by the *1999 Survey of Innovation*, which reported that 17 percent of innovators in Canada and Atlantic Canada agreed that innovation had a major impact on expanding their national and international markets. In the Atlantic provinces, 17 percent of firms in Prince Edward Island reported an increase in their international market share after introducing their innovation; the proportions were 15 and 13 percent respectively in Nova Scotia and New Brunswick. In first place is Newfoundland and Labrador, where 34 percent of firms reported that innovation had a considerable impact in increasing their international market share.

Even if the context is different, the impact of innovation on a firm's national and international markets is comparable. At the national level, 16 percent of innovators reported that innovation had positive consequences for their national market; the figure for Atlantic Canada was slightly higher at 17 percent. Among the region's provinces, variations are minimal, except in Newfoundland and Labrador, where the figure was higher, with 21 percent of firms saying that innovation contributed considerably to opening up their market throughout Canada.

Any increase in market share occurs to the detriment of other firms. About 17 percent of innovators in Canada and Atlantic Canada see their increased share of the international market as being attributable to innovation's expansion of the international market, the competition created by the opening up of borders, and the fact that 12 percent of manufacturing firms in the Atlantic region reported a world-class innovation. As for the national market, there is every reason to think that the same dynamics apply there too. Thus, the growth in market share is a very attractive consequence of innovation for any entrepreneur thinking about developing a new product or process. And Atlantic Canada entrepreneurs are not to be outdone in this area.

Higher Productivity

If this last set of effects was more related to new products, the role of innovation in increasing productivity has more to do with new processes. For its part, the increase in a firm's production capabilities has a direct impact on several factors. Whether by speeding up the manufacturing process, lowering production costs, or increasing the range

of products offered, the increase in productivity through innovation is of considerable interest to the entrepreneur. It is therefore essential to determine the scope of this impact.

It will be recalled from table 1, that over 60 percent of manufacturing firms in Atlantic Canada reported process innovations between 1997 and 1999. Let us now look at the *1999 Survey of Innovation* to see what impact these innovations may have on the productivity of firms. According to this survey, more than one out of four firms (26 percent) in the region reported that innovation had a very beneficial impact on their productivity, i.e., 3 percentage points above the national average. At the provincial level, there was similar agreement from innovators in Nova Scotia and New Brunswick (25 and 24 percent respectively). In Newfoundland and Labrador and Prince Edward Island, however, the results were somewhat different (36 and 16 percent respectively).

These numbers may seem reassuring for firms in Atlantic Canada, and yet the gap in productivity between the region and the rest of the country remains high, as highlighted in the Statistics Canada study *Differences in Interprovincial Productivity Levels*. By using value added per job as a measure of productivity that takes into account the size of a firm, its efficiency, and its worker skill level, this study drew a fairly bleak picture of the situation. According to its analysis of the primary-manufacturing sector (metal products, electronics, chemicals, etc.), productivity in 1996–97 was $54,700 per job in the Atlantic provinces and $80,900 per job in Canada as a whole. The gap is even wider in the secondary-manufacturing sector (concrete products, automobiles, rubber), where productivity was $55,500 per job in Atlantic Canada and $91,000 per job in Canada as a whole. Finally, in the "other" category (food products, textiles, pulp and paper, etc.), the difference in productivity was smaller, at $58,100 per job in Atlantic Canada and $67,700 in Canada as a whole.[17]

In short, even if innovation does have a positive effect on the productivity of Atlantic Canada firms, the difference in productivity between firms in the region and firms in the rest of Canada is still significant (this takes into account the fact that the data on productivity were slightly skewed relative to the data from the *1999 Survey of Innovation*).

---

17. J. Baldwin et al., *Differences in Interprovincial Productivity Levels* (Ottawa: Statistics Canada, 2001), 6.

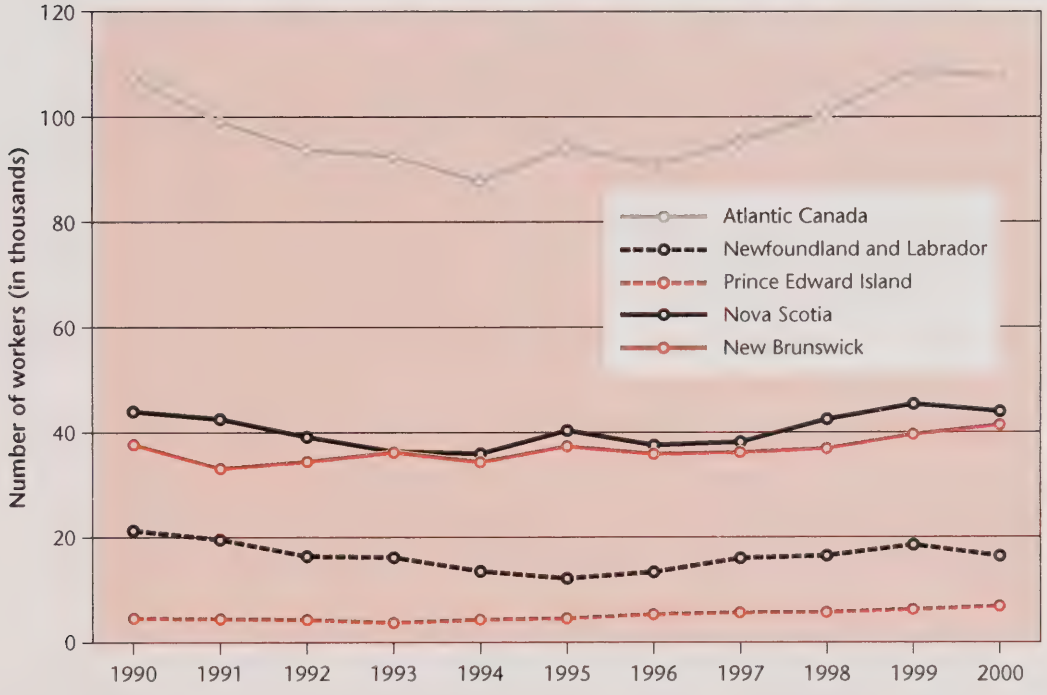
Job Creation

One of the great fears associated with innovation and the arrival of new technologies concerns their potential impact on the employment level. Often, it is mistakenly believed that as firms become more efficient their need for employees will diminish. In fact, if innovation does have an impact on employment, it is more likely to be in higher training needs and in structural unemployment. This latter impact will be the result of job losses caused by the demand for skills associated with the introduction of innovations or new technologies. Structural unemployment will only be temporary, however, if workers are capable of acquiring these skills.

Figure 6 tracks the evolution of employment in the Atlantic region's manufacturing industry in the 1990s. It shows that after a decline in the first half of the decade, the number of jobs in the manufacturing industry increased markedly in 1998 and 1999. To see if innovation played a role in this recovery, let us turn to the data from the *1999 Survey of Innovation*.

Figure 6

Evolution of Employment in the Atlantic Canada's Manufacturing Industry, by province, 1990–2000



Source: Statistics Canada, *Historical Labour Force Statistics, 2000*; compiled by Samuel LeBlanc.

According to table 5, a larger proportion of innovative firms tended to see an increase in their number of employees relative to manufacturing firms as a whole. The gap is wider in the Atlantic provinces than in Canada. In this region, 58 percent of innovative firms reported an increase in jobs, i.e., 8 percentage points more than for the sector's firms as a whole.

Table 5

Changes in Total Number of Employees in Innovative Firms and in the Manufacturing Sector's Firms as a Whole, in Canada and Atlantic Canada, 1997–99

	Variation in Number of Employees							
	Innovative Firms (%)				Firms as a Whole (%)			
	Increase	Decrease	No Variation	Undetermined	Increase	Decrease	No Variation	Unspecified
Canada	58	16	21	5	54	17	24	5
Atlantic Canada	58	16	24	2	50	18	30	2

Source: Statistics Canada, *1999 Survey of Innovation* (Ottawa: Statistics Canada, 2001). Special Order; compiled by Samuel LeBlanc.

These data should be viewed with caution as there may not be a cause-and-effect relationship in cases where innovative firms saw an increase in their number of employees. Nevertheless, according to the *1999 Survey of Innovation*, innovative firms did have more difficulty finding skilled workers. It is only from this perspective, however, that a cause-and-effect relationship can be established, albeit a tenuous one, between innovation and job creation. As this issue is discussed further in the next chapter, let us just say for now that 38 percent of innovative firms in Atlantic Canada believe that there is a shortage of skilled workers.

Finally, given all its other positive effects (higher market share, higher productivity, etc.), innovation can only contribute to the growth of firms and increase their manpower needs. Consequently, as McMillan indicated earlier, innovation also seems to be a factor that contributes to the development of employment in Atlantic Canada.

Based on our general analysis in chapter 2, we made in this chapter a more detailed examination of innovation in Atlantic Canada. In so doing, we used the manufacturing industry as a case study. Our analysis showed that a group of manufacturing firms in Atlantic Canada

are strongly committed to the race to innovate and have been quite successful in their efforts relative to other industries when compared to the rest of Canada. We also explored the extent of innovation in this sector and tried to measure its impact on the firms themselves. As the next chapter will show, however, the success of the region's manufacturing firms has not come easily.

Chapter 4

Working Together for Innovation

Up to now, our analysis has dealt mainly with the extent and impact of innovation in Atlantic Canada with very little being said about all the work that leads to innovation. This chapter will therefore look at how the region's innovators go about creating a climate that fosters innovation. At the same time, we will underscore the greater efforts of innovators as compared to non-innovators in a range of innovation-related activities.

The following analysis shows that in order to achieve a high degree of innovation, firms in Atlantic Canada's manufacturing industry have had to work hard and be open to contributions from the public and private sectors.

Tools of Innovation

"Without ideas there is no innovation. However, ideas left to themselves have little value and die easily if not nourished and supported."[1] Working in a knowledge-based economy, innovators are investing massively in information, a fact that should come as no surprise to anyone. Although ideas may occur quite by accident, organizing research activities remains the best way to establish a favourable climate for the creation of ideas that lead to innovation. To better understand the dynamics of innovation, let us now review the multiple sources of information that sustain the innovation process, beginning with the specific and working towards the general.

Internal Sources of Information

Internal sources of information come from groups which are most in contact with the products and processes of a firm, i.e., its overall operation. Table 1 provides an overview of these sources of information, the largest being the production staff. As well, over three-quarters of

1. Conference Board of Canada, *Building the Future: 1st Annual Innovation Report* (Ottawa, 1999), 30.

firms rely on the knowledge of their management staff (77 percent of firms in Canada and 87 percent in Atlantic Canada). After the management staff, the production staff is frequently asked to contribute to the innovation process of 72 percent of innovators in Canada and 76 percent in Atlantic Canada.

Table 1

Internal Sources of Information Contributing to Innovation in Manufacturing Firms in Canada and Atlantic Canada, 1997–99

	Percentage of Innovative Firms					
	Canada	Atlantic Canada	New Brunswick	Nova Scotia	Prince Edward Island	Newfoundland and Labrador
Management staff	77	87	85	86	93	92
Production staff	72	76	65	85	68	87
Sales and marketing staff	66	64	61	68	74	55
Research and development staff	53	50	48	50	58	47

Source: Statistics Canada, *1999 Survey of Innovation* (Ottawa: Statistics Canada, 2001). Special Order; compiled by Samuel LeBlanc.

A significant gap exists in this area in the Atlantic provinces, with about 65 percent of firms in both New Brunswick and Prince Edward Island using information from production staff compared to 85 and 87 percent of firms respectively in Nova Scotia and Newfoundland and Labrador.

As for the staffs in sales and marketing and R & D, they also contribute to the innovation process, but to a lesser extent. The first group's participation rate remains quite high, with two-thirds of firms in Canada and the Atlantic region using this source of information. In the second group, the low participation rate (about 50 percent) may seem surprising, but it should be remembered that a smaller proportion of firms have specific R & D departments.

External Sources of Information

Around these sources of information is another series of networks that are available to firms. The *1999 Survey of Innovation* collected data on eight external sources of information. The five main ones are addressed here.

The two groups most involved in the innovation process are suppliers and clients. In Canada, the suppliers' participation rate as contributors of information to the innovation process is 65 percent, compared to 73 percent in the Atlantic provinces. That clearly shows the value of cooperation for the region's innovators. This involvement is even higher in Newfoundland and Labrador, where 89 percent of firms use input from suppliers. In second place are clients, who are an almost indispensable source of information for innovators. Being in regular contact with products, they are well positioned to provide advice or ideas that can lead to innovations.

Among the other sources of information, the low participation rate of universities is of note, as is that of federal and provincial research agencies and laboratories. Very few firms (10 percent in Atlantic Canada) seem to benefit from the rich knowledge available from universities and colleges. With regard to federal research laboratories, the participation rate in the innovation process is slightly higher, at 17 percent for firms in Atlantic Canada — almost double the national average of 9 percent. As for provincial laboratories, 18 percent of the region's firms indicated that they play a major role in providing ideas or contributing to the development of new products or processes. That is three times higher than in Canada (6 percent).

Common Sources of Information

Lastly there are the more accessible sources of information. Trade fairs and shows, conferences, etc., are part of a traditional network that facilitates the sharing of ideas. Consequently, a significant proportion of innovators make use of these sources both in Canada and in the Atlantic provinces. In general, close to three-quarters of the manufacturing firms reported that they get information from trade fairs and shows. As for specialized sources such as conferences, professional meetings, and specialized magazines, about one out of two firms in Atlantic Canada have obtained information from them that contributed to their innovation. Finally, in addition to the traditional sources, 43 percent of firms in Atlantic Canada have consulted the Internet during the innovation process.

This overview of the sources of information used by innovative firms demonstrates that in Atlantic Canada their efforts take two forms. First, the region's innovators take a quantitative approach, relying heavily on information sources to guide their innovation process — to a degree that often exceeds the national average. Second, Atlantic Canada firms distinguish themselves by the extent of their

quest, as they explore a wide range of information sources. The question that now arises is whether firms are just as zealous in implementing these ideas. To answer this question, let us examine various innovation-related activities of manufacturing firms. Figure 1 shows to what extent innovative firms in Canada and the Atlantic provinces carry out five innovation-related activities. Each one of these will be looked at more closely. To facilitate our analysis, we gathered under one category the use of new technologies, production set up and start up activities, machinery acquisition, and industrial design and engineering.

Research and Development

We already know that R & D is one of the best means to innovate, so it is not surprising that the great majority of manufacturing firms make use of it. In 1999 funds earmaked for R & D in the manufacturing industry in Canada totalled $6.4 billion.[2] To determine the number of firms involved, we once again relied on the *1999 Survey of Innovation*, which revealed that between 1997 and 1999, 77 percent of innovators in the manufacturing sector in Canada carried out some R & D (12 percent more than for all firms). In the Atlantic provinces, in spite of the lower participation rate of all firms in R & D, as noted earlier, close to three-quarters (74 percent) of innovators in the manufacturing sector used R & D in their innovation process (again, 12 percent more than for all the region's firms).

These high numbers suggest that the manufacturing industry accounts for a disproportionate amount of R & D funds. And in fact this is supported by a quick look at the structure of R & D expenditures in Canada, which reveals that in 1999 the manufacturing industry accounted for 68 percent of R & D funds.[3]

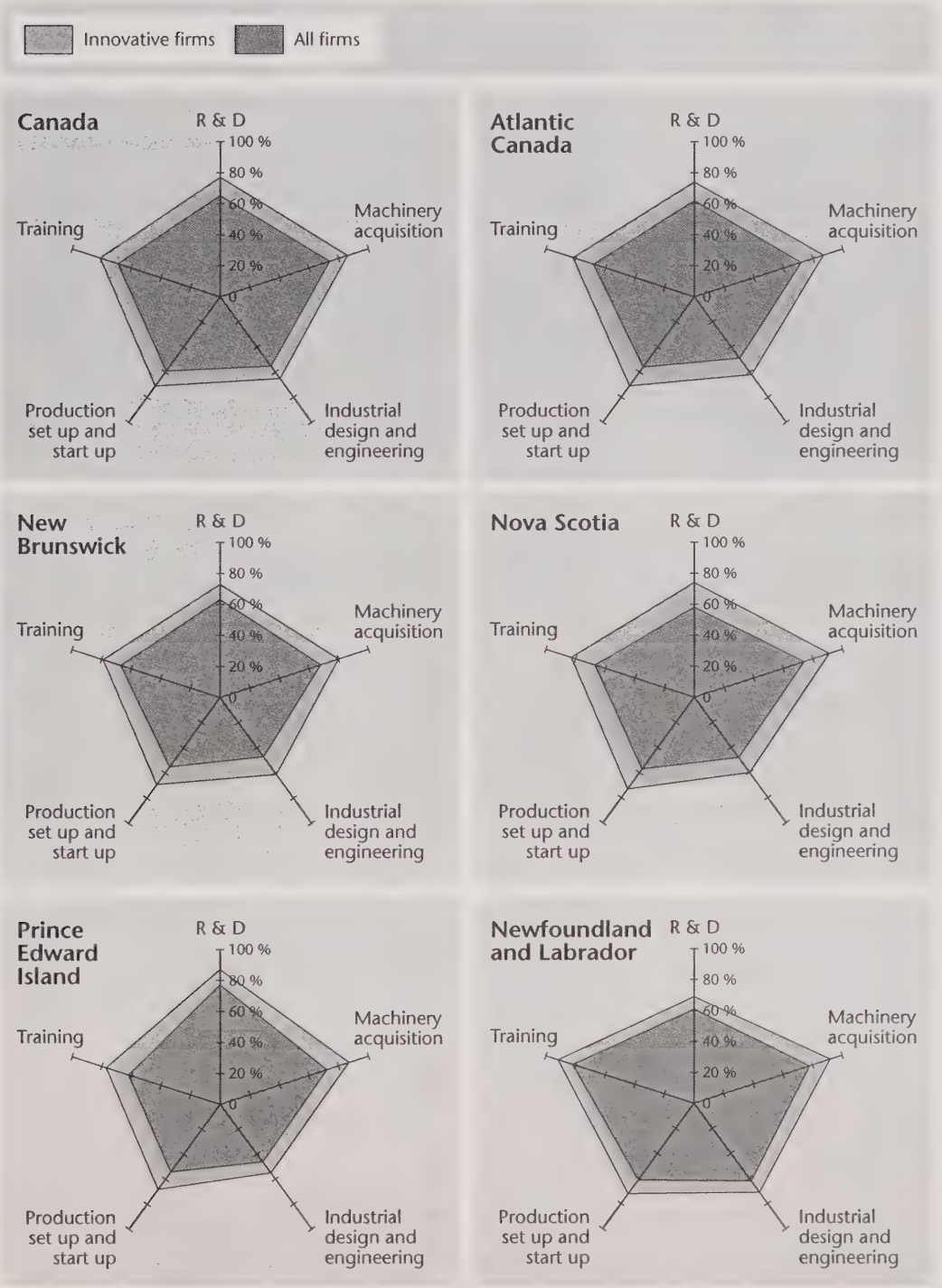
In the four Atlantic provinces, the proportion of innovators from Nova Scotia and New Brunswick who carried out R & D activities closely follows the national trend, whereas in Prince Edward Island, almost all manufacturing firms did so. Efforts are more modest in Newfoundland and Labrador, where 69 percent of innovative firms were involved in R & D between 1997 and 1999. Once again there is a sizeable gap between the proportion of innovators and the proportion of manufacturing firms as a whole in this regard. In the Atlantic

2. Statistics Canada, *Industrial Research and Development: Intentions 2000* (Ottawa: Statistics Canada, 2001), 52, table 3.

3. Ibid.

Figure 1

Participation of Innovative Firms and of Firms from the Manufacturing Sector as a Whole in Five Innovation-Related Activities in Canada and Atlantic Canada, 1997–99



Source: Statistics Canada, *1999 Survey of Innovation* (Ottawa: Statistics Canada, 2001). Special Order; compiled by Samuel LeBlanc.

provinces, this gap is in the order of 10 percent, although it is more pronounced in Nova Scotia, where it reaches 16 percent.

The frequency of R & D efforts is a determining factor in the development of new or significantly improved products or processes. In fact, according to an analysis of the 1993 *Canadian Survey of Innovation and Advanced Technology*, 56 percent of Canadian firms which introduced a new product continuously carried out some R & D, while 38 percent of such firms only occasionally did so.[4] Six years later, the *1999 Survey of Innovation* drew a very similar picture. In Canada, of the 45 percent of innovative manufacturers which carried out R & D activities through a distinct R & D department, 59 percent did so continuously. The situation is not much different when considering the data for the Atlantic provinces. Among the innovative manufacturers in Canada which had their R & D work done under contract by other firms (28 percent), close to 40 percent indicated that this was a continuous activity. A comparison with these rates shows that firms in the Atlantic region are similarly committed. Indeed, of the 33 percent of innovators which had their R & D work done under contract by other firms, 41 percent did so on a continuous basis.

Although R & D does not necessarily lead to innovation, it is nevertheless an activity that is closely related to it. In this regard, a significant proportion of innovative firms in Atlantic Canada make a sustained R & D effort and are greatly interested in it. It should be emphasized, however, that this does not change the fact that the region's absolute share both of R & D in monetary terms and of researchers is still pathetically low.

Use of New Technologies

We already have some idea of how new technologies can contribute to innovation. As Baldwin et al. have acknowledged: "New products are often accompanied by new processes. These new processes usually embed new technologies in them."[5] Therefore, we should be able to observe the effect that integrating these new technologies has on innovation in the manufacturing industry. To this end, we will examine three activities related to innovation which specifically concern technology (see figure 1).

---

4. J. Baldwin, *The Importance of Research and Development for Innovation in Small and Large Canadian Manufacturing Firms* (Ottawa: Statistics Canada, 1997), 23, table 14.

5. J. Baldwin, D. Sabourin, and M. Rafiquzzaman, *Benefits and Problems Associated with Technology Adoption in Canadian Manufacturing* (Ottawa: Statistics Canada, 1996), 11.

Acquiring machinery is one such activity; however, its general nature somewhat limits the conclusions that can be reached with respect to innovation. Indeed, when considering firms as a whole, about three-quarters stated that they had acquired machinery during the period under study; this was the case in both Canada and Atlantic Canada. Nevertheless, the proportion of innovative firms which acquired new machinery was higher by 12 percent in Canada and 15 percent in Atlantic Canada than for firms as a whole. The disparity reflects the increased physical resources surrounding the whole innovation process. This same trend is thus encountered in the four Atlantic provinces, particularly in Newfoundland and Labrador, where almost all innovators (92 percent) made this type of investment.

Linked to high technology, industrial design and engineering[6] is the least integrated activity. According to the *1999 Survey of Innovation*, nearly two out of three innovators in Canada and Atlantic Canada integrated this type of activity into their operations. In relation to manufacturing firms as a whole, this proportion represents a difference of about 10 percent.

The last of the technology-related activities, production set up and start up, fits in between the two previous activities as to the level of integration. It is true that the acquisition of technology entails an updating process that is typical of manufacturing firms. Nevertheless, the additional investments made by innovators in production set up and start up can be directly attributable to the changes required by the production process designed for innovation. Thus, in order to offer a new product or process, 71 percent of innovators in Canada and Atlantic Canada have been involved in such activities, i.e., 12 and 15 percent more respectively in Canada and Atlantic Canada (with no marked differences between provinces) than in manufacturing firms as a whole.

In short, even if the majority of manufacturing firms have to a certain extent integrated new technologies, such integration is systemically more significant among innovative firms, whatever the technology-related activity may be. Thanks to this increased effort, innovative firms have been able to acquire a maximum of new technologies, thereby creating an environment that is more conducive to innovation.

---

6. This consists of (1) using computer-based software for designing and testing new products, (2) computer-aided manufacturing that uses the output provided by CAD systems to control machines which manufacture the part or the product, (3) providing a computer-based visualization of the performance of a computer design, and (4) electronic transferring of computer-aided design files. *Source:* D. Sabourin and D. Beckstead, *Technology Adoption in Canadian Manufacturing* (Ottawa: Statistics Canada, 1999), 18.

Training

Whether it is used to instruct workers after new technologies have been integrated or to acquire more advanced knowledge of the components that have been introduced for the purpose of innovation, training is vital to the innovative process. Strictly speaking, "In manufacturing, the human resource strategy – including training – of the firm is dictated by its innovative stance."[7] Consequently, the high percentage of innovators among manufacturing firms should be reflected by an equally high trend among those firms of providing training for their workers.

We saw that overall, firms operating in the fourteen major industrial sectors are more or less inclined to provide training; this was indicated in the WES (see chapter 2, table 3). However, the situation is quite different in the manufacturing industry. According to the *1999 Survey of Innovation*, about 70 percent of manufacturing firms in Canada and the Atlantic region provided training in connection with the introduction of new products or processes between 1997 and 1999. If this rate seems high, it is even higher among innovators: more than 80 percent of these firms in Atlantic Canada and Canada provided training for the introduction of an innovation.

Among the Atlantic provinces, three are following the national trend in training with regard to both innovators and firms as a whole. In the fourth, Newfoundland and Labrador, the proportion of firms (both innovative and non-innovative) that provided training is 82 percent, i.e., thirteen points above the national figure and the same as the average for innovators in Atlantic Canada. With respect to Newfoundland innovators only, 92 percent provided their employees with training that was related to their innovation.

To complete this brief overview, table 2 presents the nature of the training provided by manufacturing firms. It shows that this sector is taking the necessary means to ensure that the skills of its labour force are evolving at the same speed as the introduction of new technologies.

In short, the high participation rate of manufacturing firms in activities that foster innovation explains in large part the degree of success achieved by innovators in the Atlantic region. Efforts to innovate in the manufacturing sector must be significant given the innovation rate of 76 percent among these firms in Atlantic Canada.

---

7. J. Baldwin, T. Gray, and J. Johnson, *Technology Use, Training and Plant-Specific Knowledge in Manufacturing Establishments* (Ottawa: Statistics Canada, 1995), 17, note 3.

Table 2

Propensity (%) of Manufacturing Firms in Canada to Train Their Workers, by Area of Training, 1998

Areas of Training	Percentage of Firms
Technical skills	88
Computer literacy	85
Safety skills	84
Quality control skills	80
Basic literacy/numeracy	31

Source: D. Sabourin and D. Beckstead, *Technology Adoption in Canadian Manufacturing* (Ottawa: Statistics Canada, 1999), 44, table 6.2.

And those same efforts must also be diversified so as to reflect the range of inputs required for an innovation to be realized.

There are two other particularly interesting activities that are directly related to the innovation process of manufacturing firms. These are collaboration and the use of government programs.

Collaboration[8]

Although globalization has generated a fiercely competitive climate that pits more and more firms against each other, it has also given rise to the opposite phenomenon: collaboration. Fed by the revolution in information and communication technologies, a large number of firms are adopting this strategy. According to the Conference Board of Canada, 4,269 alliances were formed in Canada between 1990 and 1999, of which 66 percent were on an international scale.[9] The extent of this phenomenon is demonstrated not only by the number of alliances but also by their geographic coverage.

Collaboration is also important for the manufacturing industry. According to the *1999 Survey of Innovation*, one-third of manufacturing firms in Canada and Atlantic Canada collaborated with a private or public entity between 1997 and 1999. Although the trend is fairly constant among the four Atlantic provinces, the isolation of firms in Newfoundland and Labrador seems to be detrimental to their involvement in collaboration. On the one hand, firms from Nova Scotia, Prince Edward Island, and New Brunswick all participated

8. This section is largely based on the method and content of the analysis made by the Conference Board of Canada, *Collaborating for Innovation: 2nd Annual Innovation Report* (Ottawa: Conference Board of Canada, 2000), 40.

9. Ibid., 17, table 3.

significantly in collaboration agreements (at the rate of 39, 36, and 33 percent respectively). On the other hand, only 16 percent of firms from Newfoundland and Labrador reported this kind of activity.

Eight Reasons to Collaborate

The *1999 Survey of Innovation* looked at the reasons that motivate innovative firms to collaborate. To relate the data it gathered, we used numbers collected by the Conference Board of Canada, which from 1997 to 1999 carried out its own survey on innovation with firms from various sectors. Among other conclusions reached, it revealed that innovation is at the root of collaboration. According to data collected during this period,[10] 20 percent more Canadian firms that collaborate introduced a new process than those that do not collaborate. As for the number of new processes introduced, the gap between collaborative and noncollaborative firms dropped to 10 percent, though here again it favoured the former. In both cases the reason is clear: collaboration facilitates innovation.

Table 3 outlines in greater detail the motivations behind collaboration. According to the data, access to critical skills and to R & D are the two main reasons for entrepreneurs to collaborate. Generally speaking, then, collaboration is particularly attractive to innovative firms in establishing a context that is favourable to innovation. Furthermore, the answers given by the innovators surveyed revealed that they find the steps leading to an innovation more important than the issues of cost, production, and dissemination.

This approach is particularly favoured by firms in Atlantic Canada, where nearly two out of three firms are looking for critical skills when contemplating collaboration — a proportion significantly higher than the national average (55 percent). Another innovation catalyst, access to R & D, is among the major factors that encourage innovators from the region to engage in collaboration.

Other motives behind a firm's desire to collaborate take second place in importance and chronology. And there are many reasons why a firm may decide to collaborate. For example, in addition to gaining access to critical skills, a collaboration agreement may offer a firm the opportunity to share costs and to access new markets. A successful collaboration depends on a congruence of needs between the partners, with both sides benefiting and in the end producing a sound innovation.

---

10. Ibid., 12, table 2.

Table 3

Distribution (%) of Innovative Manufacturing Firms Making Collaborative Agreements in Canada and Atlantic Canada, According to Their Motivation, 1997–99

	Collaborative Innovators	
Motivations for Agreements	**Canada (%)**	**Atlantic Canada (%)**
Access to critical skills	55	64
Access to R & D	52	54
Prototype development	48	47
Access to new markets	44	49
Cost sharing	42	44
Risk sharing	27	28
Access to new distribution networks	26	31
Scale increase for production processes	24	32

Source: Statistics Canada, *1999 Survey of Innovation* (Ottawa: Statistics Canada, 2001). Special Order; compiled by Samuel LeBlanc.

Collaborating with Whom?

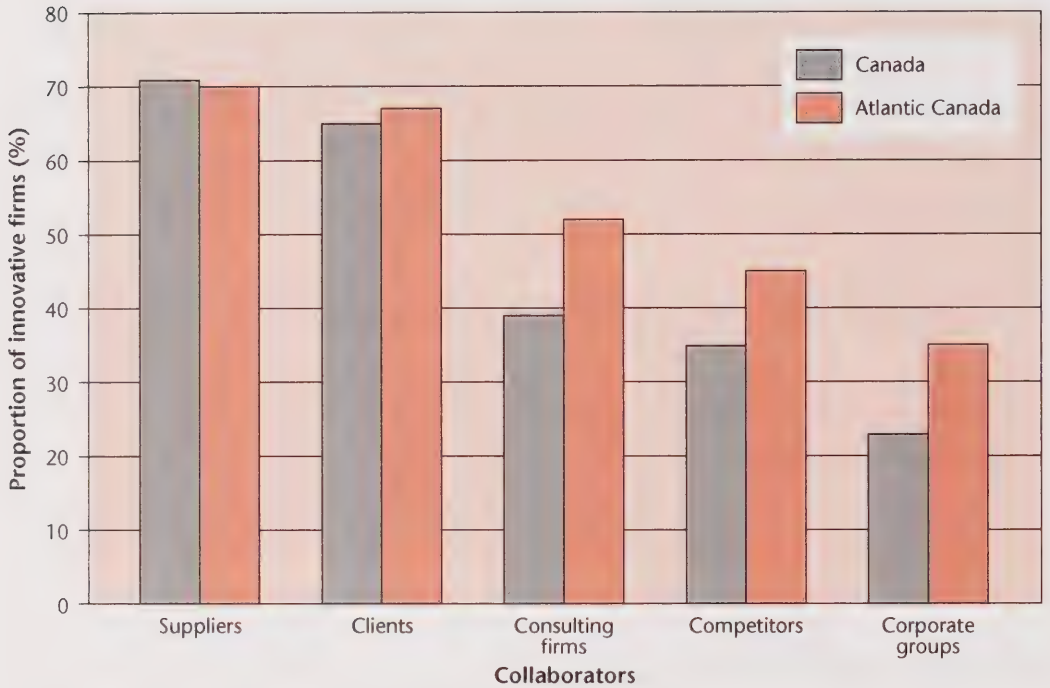
Every group that is a party to a collaboration agreement has something special to offer. In the following section, we will see that the private sector plays a much more significant role than the public sector with regard to collaboration, although together they create exchange networks and partnerships that are essential for many innovators.

Figure 2 illustrates the private sector's involvement in collaboration and shows that suppliers and clients are the groups most often called upon to participate in these arrangements. In Atlantic Canada, 70 percent of innovative manufacturing firms involved in collaboration reached agreements with their suppliers (one percent less than the national average), with an almost equivalent proportion of innovators in Canada (65 percent) and in Atlantic Canada (67 percent) collaborating with clients. As these two groups have regular contacts with firms, it goes without saying that they are active participants in collaboration agreements.

With respect to the secondary groups of collaborators, consulting firms and competitors, 39 and 35 percent respectively of innovative manufacturing firms in Canada which benefited from collaboration agreements worked together with them (52 and 45 percent respectively for Atlantic Canada). Finally, regarding firms affiliated with

Figure 2

Distribution (%) of Innovative Manufacturing Firms Having Collaboration Agreements with the Private Sector in Canada and Atlantic Canada, by Type of Collaborator, 1997–99



Source: Statistics Canada, *1999 Survey of Innovation* (Ottawa: Statistics Canada, 2001). Special Order; compiled by Samuel LeBlanc.

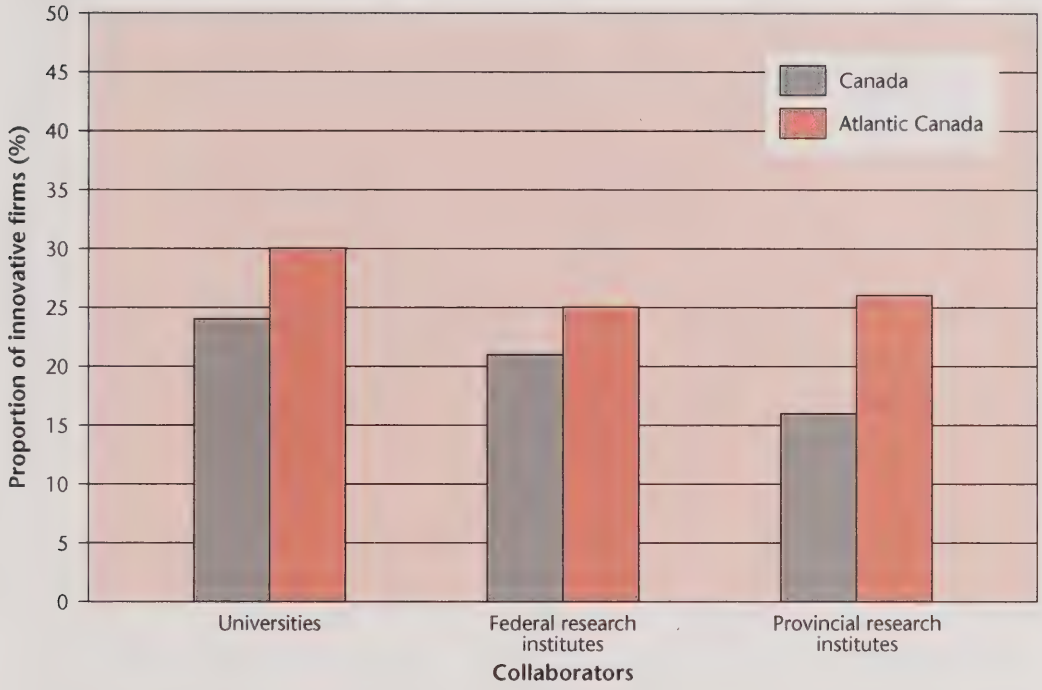
the innovative manufacturing firm (parent company, subsidiary, etc.), they were also involved in collaboration agreements in a larger proportion in Atlantic Canada (35 percent) than in Canada (23 percent).

Because of the many benefits of innovation referred to earlier, it is not surprising that so many private sector firms are willing to collaborate in order to innovate. In this regard, firms from the Atlantic provinces seem determined to involve a wide and varied range of private entities in the innovation process in order to increase their chances of success.

On the other hand, public sector collaboration in the innovation process is less extensive. It has been seen previously that although the public sector contributes in other ways to the innovation effort (through various technical assistance programs), only a quarter of innovative firms in Atlantic Canada indicated that they had collaborated with a federal or provincial laboratory (see figure 3). By com-

Figure 3

Distribution (%) of Innovative Manufacturing Firms Having Collaboration Agreements with the Public Sector in Canada and Atlantic Canada, by Type of Collaborator, 1997–99



Source: Statistics Canada, *1999 Survey of Innovation* (Ottawa: Statistics Canada, 2001). Special Order; compiled by Samuel LeBlanc.

parison, this collaboration rate is 4 and 10 percent higher respectively than the national average.

The situation is slightly more dynamic in the academic world, which has fifty-four liaison offices linking universities with firms across Canada. There are also a dozen incubators of private firms resulting from university research.[11]

It is reported that 30 percent of innovators in the manufacturing sector in Atlantic Canada have teamed up with a university. In spite of the small number of universities in the region, one out of three firms succeeds in establishing a relationship with these institutions, which offer highly skilled personnel and considerable R & D resources. Not only is this collaboration rate with the university world particularly high, but it also exceeds by 6 percent the national average.

11. Sites listed in Industry Canada's inventory: strategis.ic.gc.ca/SSGF/tf00101e.html and strategis.ic.gc.ca/SSGF/tf00118e.html (consulted 20 January 2002).

Given that firms have to remain flexible in order to adjust quickly to the ever-changing conditions of a competitive environment, collaboration enables some innovators to focus on a core set of activities and then to seek from an outside source the expertise needed to innovate. More specifically, public sector involvement through universities is essential to meet the needs of these 30 percent of innovators in Atlantic Canada that have collaboration agreements with university institutions.

Choosing Collaborators Based on Proximity

To conclude this picture of collaboration in the manufacturing industry, let us look briefly at the effect on it of distance. Although the revolution in information and communication technologies has enabled many firms to open up to the world in order to collaborate, the role of distance, or rather the proximity of collaborators, is still significant.

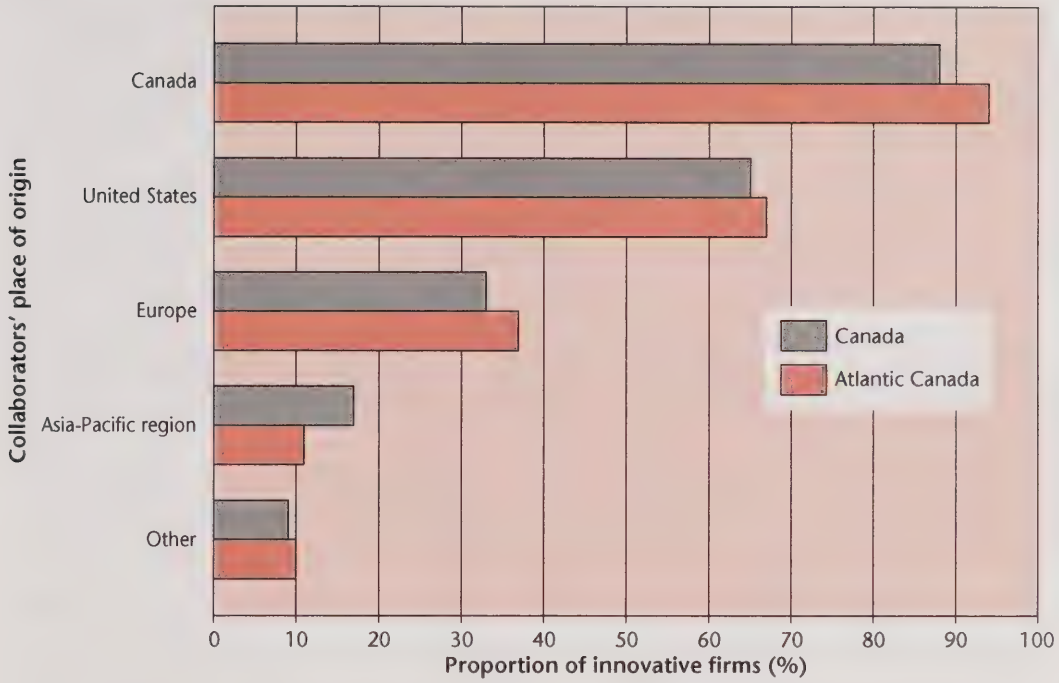
Figure 4 breaks down the collaborators with whom innovative manufacturing firms have made agreements on the basis of their place of origin. The information contained here confirms what might have been expected, that the majority of agreements have been made with Canadian or American partners. For the first group, almost all (94 percent) innovative manufacturers in Atlantic Canada which collaborated with other organizations in order to innovate did so with another Canadian entity. Outside the country, however, it is Americans by far who collaborate the most with Canadian firms. This is true for all industries in general as well as for the manufacturing industry in particular: in both cases 65 percent of Canadian firms involved in collaboration had an agreement with an American entity.[12] As for manufacturing firms in Atlantic Canada, the collaboration rate with American firms is slightly higher than the national average, at 67 percent. Finally, agreements with entities from Europe, the Asia-Pacific region, and the rest of the world, though significant, are much less common.

In the end, collaboration has proven to be an effective strategy for a good number of innovators from the Atlantic region. Its purpose is mainly to remedy the lack of available skills in the region and to provide firms with greater accessibility to R & D. Overall, collabora-

12. For firms as a whole, this number comes from the Conference Board of Canada, *Collaborating for Innovation*, 17, table 3. For manufacturing firms, it comes from Statistics Canada, *1999 Survey of Innovation*.

Figure 4

Distribution (%) of Collaborators with Innovative Manufacturing Firms in Canada and Atlantic Canada, by Place of Origin, 1997–99



Source: Statistics Canada, *1999 Survey of Innovation* (Ottawa: Statistics Canada, 2001). Special Order; compiled by Samuel LeBlanc.

tion agreements are often dictated by the proximity of the companies involved. Agreements made by Canadian firms were thus chiefly with firms from Canada, but also with those from the US. The same pattern seems to exist within the country in that firms from one province are more inclined to collaborate first with firms from the same province and then with firms from bordering provinces.

Among the factors that affect innovation initiatives, government actions are certainly important. Federal and provincial governments are not only a party to research and innovation efforts themselves; they also implement various programs to foster and oversee activities in this area. The extent to which manufacturing firms from the Atlantic provinces have used these programs is an indication of the efforts made towards innovation and of how much the public sector supports innovative initiatives. That being so, we will now look at the use of government programs by innovative manufacturers in Atlantic Canada.

Government Programs

In 1997, the beginning of the period covered by the *1999 Survey of Innovation*, the federal government announced the creation of the Canada Foundation for Innovation.[13] Starting with an operating budget of $800 million, the foundation supported innovation projects at the rate of $180 million per year over five years. To date, this has been the federal government's most solid and specific commitment to innovation. The goals[14] of the foundation, which represent "an entirely new approach"[15] to the subject, fit into an overall mobilization strategy to sustain skill development, R & D, and the adoption of new technologies, all of which promote innovation in Canada.[16] Tables 4 and 5 are based on this initiative and include as well the ninety-three federal research centres,[17] the provincial research laboratories, and the training programs — in short, all federal and provincial programs.

The six areas of government support for innovation (they were mentioned in the *1999 Survey of Innovation*) include some basic catalysts that have already been discussed: R & D, training, and integration of new technologies. Table 4 reveals that innovators in Atlantic Canada's manufacturing sector are on average more willing than those from the country as a whole to make use of government support services. Thus, about 5 percent more innovators from the region than from the rest of the country have used five of the six types of assistance available, about 10 percent more in the case of information or Internet government services. An exception to this is the tax credits for R & D, which helped 58 percent of innovators from Atlantic Canada, compared to 68 percent of those at the national level, i.e., a 10-percentage-point deficit.

---

13. Canada, Department of Finance, *Building the Future for Canadians: Budget 1997 – Canada Foundation for Innovation*, www.fin.gc.ca/budget97/innov/innove.pdf (from the introduction).
14. The suggested objectives were (1) to support economic growth and job creation, as well as health and environmental quality through innovation; (2) to increase Canada's capability to carry out important world-class scientific research and technological development; (3) to expand research and job opportunities for young Canadians; (4) to promote productive networks and collaboration among Canadian postsecondary educational institutions, research hospitals, and the private sector; and (5) *to promote these national objectives in a regionally sensitive way* (italics added). See ibid., 14.
15. See ibid., introduction.
16. For more on this overall strategy, see www.innovation.gc.ca, which is full of information on the multiple aspects of innovation in Canada.
17. Canada, *Federal Partners in Technology Transfer* (FPTT), http://scitech.gc.ca/fptt/federale.html (consulted 22 January 2002).

Table 4

Distribution (%) of Innovators Using Government Innovation-Assistance Programs for the Manufacturing Industry in Canada and Atlantic Canada, by Type of Program, 1997–99

	Tax credits for R & D	R & D Grants	Training Support	Information or Internet Government Services	Technological Support and Assistance	Venture-Capital Assistance
Canada	68	21	38	20	16	5
Atlantic Canada	58	25	40	25	26	10
Newfoundland and Labrador	50	19	54	10	40	21
Prince Edward Island	57	40	53	22	31	8
Nova Scotia	62	25	31	33	24	14
New Brunswick	56	23	43	20	23	2

Source: Statistics Canada, *1999 Survey of Innovation* (Ottawa: Statistics Canada, 2001). Special Order; compiled by Samuel LeBlanc.

Although the region's entrepreneurs generally make greater use of government assistance programs than those from the rest of Canada, the situation in absolute terms is much different. For instance, it will be remembered that in 1999, Ontario and Quebec had the majority of R & D funds in Canada, while only one percent of all R & D expenditures were made in the Atlantic provinces.

One only has to look at the level of company financing through venture capital to see the disparity between companies from Atlantic Canada and those from the country as a whole. In spite of the fact that 40 percent of innovators in Atlantic Canada have received some government assistance in the form of venture capital, the overall amount is minimal compared to that given to Ontario and Quebec. According to Macdonald & Associates Ltd., the Atlantic region received only 2 percent of venture-capital funds in Canada in 1998 and 1999, dropping to one percent in 2000 and 2001. As for Ontario and Quebec, they received 70, 73, 65, and 62 percent of the funds in each of those years. For the Atlantic provinces as a whole, the government's involvement represented 12 percent of all venture-capital expenditures in 1998, and 11 percent in 1999.[18] Thus, even if the

18. Macdonald & Associates, www.canadavc.com/industrystats.asp?cat=venturecap&year=&quarter=4 (consulted 15 April 2002).

government's involvement in innovation meets its targets, its spending in the Atlantic region will remain modest.

A similar situation exists with another federal initiative introduced in 2000, namely, the Atlantic Innovation Fund, managed by the Atlantic Canada Opportunities Agency (ACOA). The purpose of this fund was to bridge the region's economic gap and increase expenditures in innovation. The fund consisted of $300 million, with payments spread over five years, and it was intended by ACOA to address a serious problem: "The region's institutions lack the financial resources to fully access major national programs, such as the Canada Foundation for Innovation. Technology incubation models and technology commercialization mechanisms are too few and are still at a 'pilot' stage. There is an absence of financing mechanisms for innovation."[19]

The goal of the Atlantic Innovation Fund is thus to create a more favourable innovation climate for the region's entrepreneurs. As ACOA admits, however, the reality is daunting: "Spread over five years, this amounts to one tenth of one percent of Atlantic Canada's GDP."[20]

And so if the Atlantic Innovation Fund, the Canada Foundation for Innovation, and other government programs want to have a significant impact on innovation efforts in industries as a whole, they have a lot of work ahead of them. Indeed, according to the latest figures from the WES (see table 5), very few firms in Canada and Atlantic Canada are using these government assistance programs.

Table 5

Percentage of Firms in Canada and Atlantic Canada Benefiting from Government Assistance Programs for Innovation (14-Industry Average), 1999

	Training Grants	Tax Credits for R & D	R & D Bursaries	Information or Technology Transfer	R & D Partnerships
Canada	5.0	2.0	2.0	1.0	1.0
Atlantic Canada	7.0	1.6	1.7	1.0	0.4

Source: Statistics Canada, *1999 Workplace and Employee Survey* (Ottawa: Statistics Canada, 2001), Special Order; compiled by Samuel LeBlanc.

19. ACOA, *Atlantic Innovation Fund, Framework Paper,* www.acoa.ca/f/financial/aif/framework.shtml (consulted 15 January 2002).

20. Ibid.

Given the official involvement of the various levels of government, it is difficult to determine if this very small percentage is due to limited access to programs, a lack of information, or an application process that the government has made too complicated. Since this will be discussed further in the next section, let us just say for now that the joint work done by the government and firms in the area of innovation remains negligible for industries as a whole, and that applies to both Canada and the Atlantic region.

Finally, even if the region's firms are making some use of government programs, only the manufacturing firms seem to be doing it to a significant degree. Still, considering the amounts paid out, a point emphasized by ACOA, it is clear that all industries could benefit from more government involvement.

Given the complexity of the subject, the number and variety of stakeholders involved, and the extent of the resources requiring investment (not to mention the technologies to be integrated), it is a major challenge indeed to present a complete picture of the innovation efforts being made by the region's entrepreneurs. However, our analysis of the major innovation catalysts has indicated the effort required for an idea to be transformed into a new product or process. And in this regard, Atlantic Canada's manufacturing firms have shown a perseverance that compares favourably with the determination of their counterparts in the rest of the country.

In order to understand the hard work of these innovative manufacturers, we must consider the various problems and obstacles they had to overcome in developing their innovations. In addition, analyzing the challenges faced by these innovators is an essential research tool in facilitating innovation. It is with this twofold objective in mind, then, that we begin the following analysis.

Innovation Problems and Obstacles

Considering that the manufacturing sector in the Atlantic region, the specific subject of this study, is being touted as a model of success in innovation, it may seem surprising that so much attention is being paid to the problems encountered by innovators. And yet the *1999 Survey of Innovation* reported that 42 percent of manufacturing firms in the region, both innovators and non-innovators, failed at least once in an attempt to innovate (or had been unable to bring an innovation to fruition before the survey was carried out). The situation is no better if only innovators are considered, as more than half said that

between 1997 and 1999 they too failed in their efforts to develop an innovation. That being the case, it is important to study the problems and obstacles faced by innovators and to make firms aware of them so they may be better prepared to solve them.

In the previous chapters, several of the innovation-related problems encountered by industries as a whole were highlighted: the lack of highly skilled human resources, the limited integration of new technologies, and the tendency to imitate the products and processes of rival firms instead of introducing new ones as world or Canadian firsts. Although manufacturing firms are not as affected by these problems, they are still faced with many more, as shown by the *1999 Survey of Innovation.*

Financial and Commercial Barriers to Innovation

The first concern surrounding innovation is the high cost of the many resources required to transform an idea into a new product or process. In fact, the risk is such that "innovation projects may expose the firm to high levels of risk, or excessive costs. In a highly competitive environment, these will lead more frequently to bankruptcy, often discouraging innovative behaviour."[21] With this in mind, let us take a detailed look at how innovators are affected by the high cost of innovation.

Costs of Innovation

The decision to innovate can easily lead to increased costs since it often results in higher expenditures in various areas such as R & D, acquisition of machinery, equipment or advanced technologies, or staff training. According to the *1999 Survey of Innovation*, 63 percent of innovators in Atlantic Canada said that high costs were the obstacle most often encountered in the innovation process. In Canada as a whole, the situation is similar: 59 percent of innovators reported the same problem. In the Atlantic provinces, the rates were 57 percent in New Brunswick, 60 percent in Prince Edward Island, 65 percent in Newfoundland and Labrador, and 69 percent in Nova Scotia.

The cost of capital, equipment, software development, and technology acquisition, including higher maintenance expenditures, all contribute to the final bill. The 1993 survey on advanced technology showed the extent of the problem: 84 percent of the manufacturing

21. J. Baldwin et al., *Innovation in Dynamic Service Industries* (Ottawa: Statistics Canada, 1998), 55.

firms in Canada that had acquired advanced technologies encountered problems in financing their investments.[22] Five years later, the situation had changed slightly. The 1998 survey reported that 61 percent of manufacturing firms in Canada considered their equipment costs as "moderately" or "highly" significant obstacles to the introduction of advanced technologies, while 50 percent thought the same for capital costs, and 44 percent for the integration costs of these technologies.[23]

The *1999 Survey of Innovation* also noted that advanced technologies rapidly become outdated. According to this survey, close to 45 percent of manufacturing innovators in Canada and Atlantic Canada "agreed" or "strongly agreed" with the statement that production technologies evolved rapidly. So in addition to increasing costs, the limited life cycle of technologies restricts their use.

This brief overview has shown that two out of three innovative firms in the Atlantic provinces believe that they had to overcome obstacles related to the costs of advanced technologies — slightly higher than the Canadian average. It is therefore crucial that innovators be able to anticipate as much as possible the costs involved in innovation in order to arrange the required financing.

Financing

According to the OECD, the relationship between innovation and financing raises problems that can be discouraging for entrepreneurs. It stated that innovation "is often risky and subject to considerable monitoring problems. Investors have difficulty appropriating some of the returns and may therefore be reluctant to finance innovative activities and innovative firms."[24] This certainly seems to be the case for the Atlantic provinces, which, as was demonstrated earlier, receive only a very small share of the venture capital in Canada. Consequently, it is not surprising that according to the *1999 Survey of Innovation*, close to one-third of manufacturing firms in Canada (29 percent) and in Atlantic Canada (33 percent) believe that the lack of financing is a major obstacle to innovation. In the Atlantic provinces, 28 percent of New Brunswick firms encountered financing problems, compared to 34 percent in Nova Scotia, 38 percent

---

22. R. Baldwin and Z. Lin, *Impediments to Advanced Technology Adoption for Canadian Manufacturers* (Ottawa: Statistics Canada, 2001), 9, table 4.

23. Sabourin and Beckstead, *Technology Adoption in Canadian Manufacturing*, 52, table 8.1.

24. OECD, *A New Economy? The Changing Role of Innovation and Information Technology in Growth* (Paris: OECD, 2000), 33.

in Newfoundland and Labrador, and 40 percent in Prince Edward Island. In the case of the last three provinces, the rate is from 5 to 10 percentage points above the national average, which makes it a serious problem.

To deal with this reality, two strategies have been suggested: collaboration and the use of government programs. In the present context, the question is whether or not these strategies have been successful. With respect to the former, the *1999 Survey of Innovation* revealed that a little less than 6 percent of firms in Atlantic Canada reported the lack of collaboration with other firms as a problem. In three of the four Atlantic provinces the trend is the same; the exception is New Brunswick, where only 1.6 percent of firms said that the lack of collaboration was a problem. Since 44 percent of the region's innovators considered collaboration as a way of overcoming the costs of innovation, it is seen as an attractive strategy for the Atlantic region.

With regard to government programs, a significant number of innovators in Atlantic Canada could not meet the eligibility requirements for receiving R & D financing. According to the *1999 Survey of Innovation*, 17 percent of Canadian firms had trouble meeting the requirements of government R & D assistance programs. In the Atlantic provinces, the figure rose to 20 percent of firms, i.e., one out of five. New Brunswick is less affected, with 14 percent of manufacturing firms having problems in this area, compared to 18 percent in Prince Edward Island, 24 percent in Nova Scotia, and 26 percent in Newfoundland and Labrador. Overall, then, it can be said that the Atlantic region has serious R & D problems.

In light of this analysis, it is clear that a significant proportion of the region's innovators have had funding problems. Neither in-house funding nor the use of government programs has been able to fully meet the needs of innovators. Only collaboration has proven less problematic.

Marketing Problems and Client Indifference to Product Innovation

Firms that have met their cost requirements and arranged the necessary financing for their projects can still be faced by two notorious problems. The *1999 Survey of Innovation* mentioned the first one when it indicated that several firms lacked the ability to market their innovation. This is a fairly common problem, one that has been encountered by 21 percent of manufacturing firms in Canada and Atlantic Canada. The situation is much the same in each of the Atlantic provinces.

The second major problem faced by product innovators is particularly devastating. A significant number of them reported that in some cases their clients had greeted their new product with complete indifference. Twenty-one percent of firms in Canada have had to deal with this kind of problem, and the situation is even bleaker in the Atlantic region, where 26 percent of firms saw their innovations fail. In New Brunswick and Prince Edward Island, 18 and 21 percent of innovators respectively reported a similar experience, compared to 29 and 33 percent respectively in Nova Scotia and Newfoundland and Labrador.

Our analysis has highlighted a few serious problems for innovators and non-innovators in the Atlantic provinces. Although the majority of entrepreneurs in Canada reported problems in this area, the high costs of innovation have hit those in the Atlantic region a little harder. Problems with financing, marketing, and the response of clients contribute to a climate of uncertainty that has deterred many investors.

Labour and Knowledge Related Problems

"With few exceptions, innovation is the result of unusual effort. The firm that successfully implements new or improved ways of competing is the one that doggedly pursues its approach, often in the face of obstacles. The strategy is the personal crusade of an individual or a group."[25] The following sections will show that problems related to human resources are twofold. First, innovative firms sometimes have difficulty recruiting sufficient labour. Second, access to knowledge, which is not unrelated to human resources, is also a significant, though less tangible, problem.

Problems with Workforce Allocation, Shortage, and Rigidity

With the rationalization of manufacturing firms in the late 1980s[26] and the modest improvement in employment in the late 1990s, entrepreneurs from the Atlantic provinces and elsewhere have fallen victim to their own decisions. Thus, according to the *1999 Survey of Innovation*, a high proportion of the region's innovative firms have had difficulty recruiting skilled workers. Indeed, 38 percent of firms complained of a shortage of skilled labour in Atlantic Canada, compared

25. M. Porter, *Competitive Advantage of Nations* (New York: Free Press, 1990), 49.

26. M. Beaudin and S. Breau, *Employment, Skills, and the Knowledge Economy in Atlantic Canada* (Moncton: Canadian Institute for Research on Regional Development, 2001), 62.

to 41 percent in the country as a whole. Provincially, 34 percent of firms in Nova Scotia, 36 percent in Prince Edward Island, 40 percent in New Brunswick, and 47 percent in Newfoundland and Labrador reported problems recruiting skilled labour. Although the extent of the problem warrants further study, the fact remains that relative to the rest of the country, the region's innovators do not appear to be overly affected. This may seem paradoxical, but it could be explained by the local propensity to collaborate. Indeed, innovators seem to have solved this problem, at least partly, through collaboration agreements, since the search for skills is a priority of collaborators in the region.

Figure 5 shows the categories of workers whose scarcity is most felt in the manufacturing industry in Canada. The relatively small gap between occupational categories for which a shortage of skilled labour has been reported by entrepreneurs shows that if these needs do not all reach a critical level, they are systematic.

How this shortage affects the introduction of new technologies is, according to Sabourin, *ex ante*. In other words, firms start by purchasing the desired technologies and then meet their labour needs.[27] Insofar as the integration of new technologies is related to innovation, this explanation also applies to innovators. However, since innovation is a process and not a purchase, the shortage of personnel would materialize during the development of the new product or process.

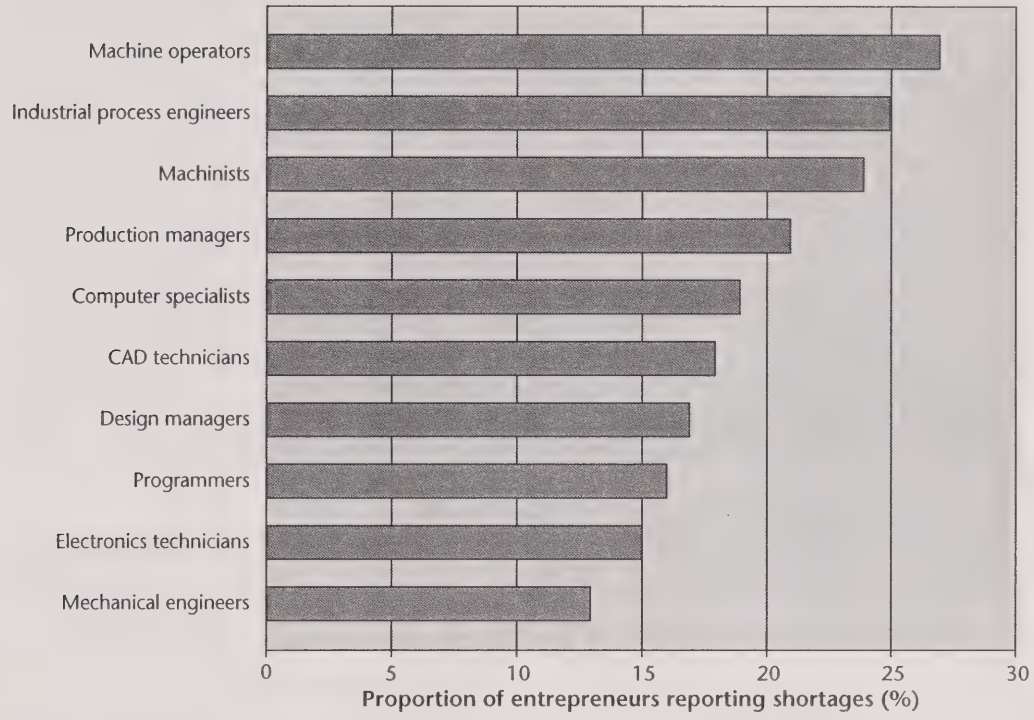
To remedy this shortage of skilled labour, two options are available:[28] training and recruiting. It has already been shown that entrepreneurs in the manufacturing industry in Atlantic Canada are doing quite well with regard to training; that is why we will focus here on their recruiting practices. During the *1999 Survey of Innovation*, 57 percent of the region's innovators indicated that they "agreed" or "strongly agreed" that it was difficult to hire skilled workers, which is not surprising given the competitive environment in which they operate. Nevertheless, this high proportion is still lower than the national average of 64 percent. On a still more encouraging note, the survey also reported that once these workers were hired, a smaller number of innovators in the Atlantic region (28 percent) had problems retaining their employees than was the case nationally (35 percent).

The hiring strategy also responds to the second problem faced by more than one innovator with respect to labour. A large proportion

27. Statistics Canada, *Innovation Analysis Bulletin* 3, no. 3 (October 2001): 3.
28. Ibid.

Figure 5

Skill Shortages in the Manufacturing Industry in Canada, by Occupational Category, 1998



Source: D. Sabourin, *Skill Shortages and Advanced Technology Adoption* (Ottawa: Statistics Canada, 2001), 6. No. 11F0019MIE.

of entrepreneurs in the manufacturing sector (both in Canada and Atlantic Canada) reported serious problems related to the allocation of staff to specific projects owing to production constraints. In Canada and Atlantic Canada, 61 percent of innovators indicated that this was a major problem when the time came to innovate. Among the Atlantic provinces, innovators in Newfoundland and Labrador seem to have partly avoided this problem, as only 40 percent stated that they had had such difficulties.

Access to Knowledge

The shortage of skilled or highly skilled labour has an impact not only on the quantity of resources available but also on access to knowledge, which is crucial in the area of innovation. Insofar as innovation depends on ideas, the higher the concentration of knowledge in a firm (or the more accessible it is), the more likely it is that ideas will result in innovations. Conversely, when entrepreneurs cannot access a sufficiently large knowledge pool — a situation that is more common than we would like to admit — their prospects for success in

innovation are greatly jeopardized. When faced with such a problem, innovative firms often turn to knowledge holders. In this connection, Breau reported that "approximately 61 percent of biopharmaceutical firms [geared towards knowledge and innovation] in Atlantic Canada have collaborative technical alliances with universities that cover a broad range of research activity."[29]

In the case of the manufacturing industry, there seems to be no cause for alarm as only small minority of innovators indicated that they had been unable to access university know-how. In Atlantic Canada, only 2.6 percent of innovators reported this problem, i.e., 3 percentage points less than the national average (5.6 percent). There is, however, a certain polarization within the Atlantic provinces. In Prince Edward Island and New Brunswick, no innovative firms reported problems in accessing university know-how, whereas in Nova Scotia and Newfoundland and Labrador, the proportion was 3.9 and 8.4 percent respectively.

Access to knowledge is also provided by government laboratories. Overall, very few firms reported any problems in accessing knowledge from these laboratories. Only 3.7 percent of innovators in Atlantic Canada encountered problems in this regard, while the national average was 4.7 percent. However, disparities still exist among provinces. Although no firms in New Brunswick reported any such difficulties, some were experienced by 3.9 percent of innovators in Nova Scotia, 9.2 percent in Newfoundland and Labrador, and, surprisingly, 10.8 percent in Prince Edward Island — more than double the national average.

We outlined the problems, obstacles, and failures experienced by innovators. Struck by the high percentage of projects that were abandoned or uncompleted at the time of the *1999 Survey of Innovation*, and the number of entrepreneurs that made no attempt to innovate, we tried to better circumscribe these difficulties. The nature of the problems faced by Atlantic Canada manufacturers in their pursuit of innovation should not surprise anyone. Thanks, however, to the *1999 Survey of Innovation*, we achieved an empirical understanding of the ones that have a pressing need to be solved.

---

29. S. Breau, *Profile and Prospects of the Biopharmaceutical Industry in Atlantic Canada* (Moncton: Canadian Institute for Research on Regional Development, 2001), 77.

Part 3

A Regional Innovation Policy for Atlantic Canada: Stakeholders, Institutions, and Governance

Yves Bourgeois

Chapter 5

Towards a Framework for Regional Innovation Policy

Part 1 of this study outlines the potential for and limits to regional development of key topics preoccupying business and policy: innovation, knowledge, R & D, productivity, and clusters. Part 2 then explores statistical trends in Atlantic Canadian innovative activity. Finally, in light of what the theory and numbers reveal, part 3 maps a framework to guide regional innovation policy.

This chapter borrows a regional system of innovation (RSI) perspective in order to analyse the multitude of innovation stakeholders interacting in the regional system. RSI acknowledges the importance of R & D, but views these activities as only one of a number of sources of innovation. Firms are not isolated but interact in systems. Key to RSI is examining the various innovation stakeholders as well as the formal and informal institutions that organize incentives, reduce uncertainties, and facilitate interaction. First, however, I debunk a number of myths that limit regional innovation policy-making.

Dispelling Ten Myths About Innovation

The purpose of this section is to identify a number of beliefs that have hindered a better understanding of the role of knowledge, innovation, and related policies in regional development. What have we learned, and what are we learning about innovation policy-making?

Myth 1: Innovation Is the Only Engine of Economic Performance

Fanfare surrounding the knowledge-based economy (KBE) has led to claims that innovation is the most important factor determining the wealth of regions. Although this study recognizes innovation as a key piece to the puzzle, it is important that we understand how and where it fits. Innovations may introduce new technologies, but without skills and organizational capacity, the productivity gains of firms are limited. And innovations may present opportunities for

commercialisation, but those opportunities also depend on quality networking, marketing, and trade activities. Part 1 outlines a number of paths by which innovations contribute to regional growth and illustrates the still imperfect nature of the indicators by which we attempt to measure their role and impact.

Myth 2: Innovation Means New Technologies

Table 2 of chapter 2 shows that while 14.2 percent of Atlantic Canadian firms have innovated by introducing new technologies, second to Manitoba for the lowest rate, 36.5 percent of Atlantic Canadian firms innovated while introducing no new technologies, the highest rate in the country. As argued in part 1, the nature and sources of innovations are much broader than a limited view of innovation as new technology would suggest.[1] Andrei Sulzenko of Industry Canada writes: "In the new economy, adaptation means innovating on all fronts – adopting not only the 'hard' technologies such as information and communication technologies, but also the more flexible organisational structures, new management strategies and innovative human resource developments that are needed to make the hard technologies work. Failure to adopt these complementary innovations has meant failure to realise the productivity potential of the new technologies."[2] Sulzenko reminds us that the adoption of technology is important to innovation, but more important are the skills and organization upon which technology relies.

Myth 3: Innovation Is Driven by Scientific Research

There is a tendency to overstate the importance of R & D, in particular of science-driven R & D, to economic performance generally and to innovation specifically. This myth is a legacy of an older, linear view in which R & D leads to innovation and in turn to increased productivity and profitability. "Governments in most jurisdictions support research and development programs in the belief that these investments have a positive, if indefinable, effect on economic growth.... However, increases in knowledge alone do not fully explain or account for the capacity to generate innovations within a society or to

---

1. "Innovation encompasses much more than technological change.... [It is] a complex process that can be managed to enhance the probability of successful development and implementation of new or significantly improved products or processes": see Conference Board of Canada, *Collaborating for Innovation: 2nd Annual Innovation Report* (Ottawa, 2000), 6.
2. Andrei Sulzenko (assistant deputy minister, Industry and Science Policy, Industry Canada), "Technology and Innovation Policy for the Knowledge-Based Economy: The Changing View in Canada," *STI Review*, 22 (1998): 285–305.

generate growth."[3] R & D contributes to innovation, theoretical and empirical evidence presents us with two caveats. First, one study[4] suggests that patents are more relevant to some industrial activities than others. The same argument applies to R & D: scientific R & D is an important source of innovation for a number of science-driven industrial activities such as biopharmaceuticals, chemicals, and advanced materials, while for other industries R & D is less important. Second, for all industries, including those that rely more on scientific research, R & D is only one of several sources of innovation. As mentioned in part 1, Hollander, as early as 1965, showed that most of DuPont's innovations came not from their R & D labs or personnel but from managers and shop-floor workers proposing new ideas on how to improve products and processes based on daily tasks, routines, and experiences. More recently, despite spending considerably less on R & D than Erickson (9 percent of sales versus 15 percent), Nokia's performance indicates that the myriad other factors shaping innovation must also be considered.[5] "... collaboration within private sector firms (suppliers, customers, consulting firms, and competitors) — so-called interfirm collaboration — is more prevalent than the partnering of private sector firms with publicly funded research organizations (universities and federal/provincial research laboratories).... private sector collaboration with universities and government labs is likely to cover a narrow range of areas — mainly access to scientific advances and research expertise — whereas the interfirm collaboration will cover more areas, thus increasing the possibility that such collaboration will occur."[6]

Innovation efforts and policies that are limited to celebrating and fostering a region's science base are bound to reduce the potential gains from wider innovation efforts. Moreover, the greatest contribution to innovation studies in the last decade has been the extension of the analysis to other sources of innovation and the recognition that they emerge through competitive and collaborative interactions with

---

3. J. A. Holbrook and D. Wolfe, "Innovation Studies in a Regional Perspective" in J. A. Holbrook and D. Wolfe (eds.), *Innovation, Institutions, and Territory* (Montreal: McGill-Queen's University Press, 2000), 2.
4. J. Baldwin, P. Hanel, and D. Sabourin, *Determinants of Innovative Activity in Canadian Manufacturing Firms: The Role of Intellectual Property* Rights (Ottawa: Statistics Canada, 2000), 9.
5. A. Leiponen, *Essays in the Economics of Knowledge: Innovation, Collaboration, and Organizational Complementarities* (Helsinki: Helsinki School of Economics and Business Administration, 2000), 1.
6. Conference Board of Canada, *Collaborating for Innovation*, 16.

other stakeholders, interfirm collaborations in particular, not from individual and isolated R & D experiments: "Thus innovation policy has only recently emerged as an amalgam of science and technology policy and industrial policy. Its appearance signals a growing recognition that knowledge in all its forms plays a crucial role in economic progress, that innovation is at the heart of this 'knowledge-based economy,' and also that innovation is a more complex and systemic phenomenon than was previously thought."[7]

Government initiatives limited to R & D tax credits and investments are valuable to sectors reliant on scientific research. They serve to correct market failures when private R & D financing lags behind the needs of local innovators. Far from suggesting that R & D tax and subsidy programs are detrimental to innovation, the R & D myth makes these programs inadequate. Strategies targeting increased local R & D expenditures should be mindful that greater benefits come from a wider slate of smarter and more adaptable local firms than from a handful of patent-holding companies. In other words, existing R & D programs focus on the tip of the iceberg, while a much greater innovation potential for the whole economy remains hidden beneath the surface.

Therefore, debunking the scientific R & D myth involves recognizing which R & D activities are important, why they are important, and where they are located. R & D activity and indicators are informative for three reasons. First, scientific R & D investments are crucial to science-based industrial activities, such as biopharmaceutical, chemical, and advanced material industries. Ascertaining which industries are present in the region and what strengths the region has will help us to understand the extent of any apparent gaps in R & D spending.

Second, government spending on research and development are extremely important in supporting basic research that is not profitable to firms but that supports valuable and profitable applied industrial research. Empirical evidence suggests that basic research may provide greater local economic benefits because it does not "travel" well and so promotes the clustering of firms that rely on basic research. Moreover, supporting basic research helps employ and train R & D personnel, who provide an essential link to the private sector through

7. OECD, *The Measurement of Scientific and Technical Activities: Proposed Guidelines for Collecting and Interpreting Technological Innovation Data — The Oslo Manual* (Paris: OECD, 1996), para. 8.

collaborations or by becoming entrepreneurs. Government R & D tax and subsidy programs must be accompanied by efforts and programs to link basic or applied research done in government labs not only with applied research in private R & D labs but also with the commercialisation potential of a wider array of firms.

Third, perhaps the greatest benefit of R & D investments and activity lies in developing the absorptive capacities of firms in the region. Absorptive capacities are the ability of firms to scan and identify (e.g., competitive intelligence), as well as the ability to interpret, understand, and apply valuable ideas originating elsewhere, including R & D done by government labs or competitors. In this sense R & D, as more broadly defined by *The Frascati Manual*, enables firms to tap into much larger pools of research and knowledge than they could develop internally. R & D becomes much more accessible and beneficial to firms learning to incorporate outside ideas into internal production processes or identifying new niches.

Myth 4: Innovation Efforts Are Successful Only If They Yield New Products or Processes

The benefits of innovation are not limited to successful innovators. They extend to those who endeavour to innovate, even if unsuccessful, as well as to those who imitate the work of others. First, the OECD *Oslo Manual* recommends distinguishing between firms that try to innovate but produce no results and firms that make no innovative efforts at all.[8] For the former, it may be a case of some innovations involving a lengthy process or projects being aborted. Whatever the reason, firms that try but fail to introduce new products or processes tend to be more dynamic than firms that make no such efforts.

Second, market scale means that there is a degree of fluidity between those who innovate and those who imitate their work. Both the *1999 Workplace and Employee Survey* and the *1999 Survey of Innovation* asked firms to distinguish between innovations that are world firsts, national firsts, and local firsts, suggesting that innovators at the local level may be imitating the work of firms outside the region. Company efforts and public policies designed to pursue innovation also serve to increase absorptive capacities, i.e., the ability to identify and understand innovations and incorporate them into internal production. Although they may not lead to world- or even local-firsts, efforts to innovate increase the competitiveness of

8. Ibid., para. 230.

firms and their regions because at a minimum they improve market responsiveness. The Conference Board of Canada's second report on innovation reminds us that "for smaller economies such as Canada's, which account for but a small share of the world innovation effort, technology diffusion contributes more to productivity growth than does the country's R & D effort."[9] By staying at the forefront of industry developments and leading-edge innovations, firms remain competitive, improve their innovative mindset, and increase the likelihood of producing future innovations.

If innovative efforts also reap rewards for firms imitating the work of others, is the incentive to innovate being undermined? Why should innovative firms bother undertaking expensive projects if greater economic benefits accrue to competitors commercialising or finding new applications for their ideas? There are three reasons why the work of imitators should not pose a threat to innovation. First, intellectual property rights, such as patents and copyright laws, help ensure temporary monopoly rents so that innovators can recover costly research investments. Although important for scientific research-based sectors, they apply less to the many firms whose incremental innovations may not be amenable to patenting.

Hence, a second reason why imitation need not undermine innovation is that most innovations do not come from expensive research activities. The explosion of interest in knowledge management in recent years is a recognition by managers and consultants that the greatest challenge for firms and the greatest potential for leveraging knowledge involves tapping into the reserves of tacit knowledge, expertise, and experience that reside in a firm's employees and processes. Hewlett Packard CEO Lew Platt once remarked, "If only HP knew what HP knows, we could be three times as profitable."[10]

The third reason why imitation should not threaten innovation is that some sources of knowledge are not internal to firms at all. Instead, they belong to a firm's external relations with partners, customers, suppliers, and competitors. They are difficult to imitate because they are dependent on relationships that are region-specific. Unlike the case of Microsoft, which is the king of the Redmond castle, Silicon Valley is successful not because of any one individual firm and how well it harvests worker knowledge but because of the way vari-

9. Conference Board of Canada, *Collaborating for Innovation*, 8.

10. Quoted in L. Prusak (ed.), *Knowledge in Organizations* (Boston: Butterworth-Heinemann, 1997).

ous stakeholders interact, including firms, venture capitalists, local governments, etc. The emphasis shifts from individual firms to the system as a whole, and therein lies the importance of regional systems of innovation.

Myth 5: Innovation Impacts New, not Traditional Industries

Myth 2 equates innovation with new technologies. Similarly, there is a tendency to think of innovation as involving new or high-tech industries only. The term *traditional industries*[11] is an unfortunate choice of words. There is no inherent reason to suppose that a greater potential for economic development lies in new industries than in existing industries. Innovation policies should target firms from all sectors in need of skilled personnel — firms searching for process improvements and better ways to organize production — as well as pursuing cost reduction, market expansion, and higher value-adding strategies.

Myth 6: Knowledge Intensive Sectors Are More Profitable

This myth stems from all the attention that has been given to the knowledge-based economy. On one hand, knowledge has always been an essential part of goods and the economy. Throughout the centuries, the quality and price of craft-based production such as handmade furniture or textiles depended on the knowledge and skill of the artisan. The KBE argument is that the information and knowledge now embodied in goods is greater in terms of sophistication, quantity, or intensity. Economic logic tells us, however, that this does not explain higher value or prices. Here, the reader is referred to the discussion in part 1 on knowledge production and value, which is summarized as follows.

In terms of knowledge quantity and sophistication, we know that personal desktop computers are several times more powerful and infinitely less expensive than the computer that navigated the first humans to the moon. Hence, it is not the *absolute* amount or sophistication of knowledge that determines its value but rather its scarcity, the *relative* availability of this knowledge. NASA had to build its systems from scratch, but clone manufacturers use relatively abundant knowledge. The same applies to the knowledge-intensity argument.

---

11. "We need to support our traditional manufacturing and natural resources industries that continue to prove that Canada can compete with the world": see Canada, *Achieving Excellence: Investing in People, Knowledge, and Opportunity. Canada's Innovation Strategy* (Ottawa, 2002), 1.

No matter how much of a given product consists of knowledge, the value of that knowledge depends on its scarcity. Some goods or services consist entirely of knowledge, such as news, but few people are willing to pay more than a dollar for a newspaper if they can access the same information from another newspaper or on-line. Even if the desired information is extremely useful to the reader, the fact that it is reported in several sources means it is not scarce and cannot demand a high price.

Firms that promise higher profits are therefore not those whose knowledge is *intensive* but those whose knowledge is *scarce*, not easily duplicated. This is why niche markets (where firms specialize in production that few competitors can emulate) are so profitable. Nevertheless, the benefits of a given innovation can only be temporary as competitors eventually catch up and markets evolve. Successful knowledge-producing firms and regions are those whose knowledge does not diffuse or travel well, whose knowledge is "sticky" in time and place. Profitable knowledge is produced when firms are able to stay ahead of the curve or when knowledge is poorly understood outside the network of spatially concentrated firms where it is produced.

Myth 7: Distance Is Dead, or the Internet As Manna to Peripheral Regions

Believing the knowledge-intensity myth will likely convince you that the Internet holds infinite promise for peripheral regions. Why? Because if information and knowledge are essential to today's economy and such knowledge is increasingly accessible via the Internet, then communities that are "connected" have the same economic opportunities as any other community. There is both truth and myth in this assertion.

The truth is that the Internet allows increased opportunities for marketing and, most interestingly, for collaboration. The nature and amount of information exchanged (documents, spreadsheets, video files), the speed (broadband) and ease (wireless) with which it is transmitted allow for immense collaborative potential (video conferencing, on-line document collaboration).

The myths are twofold. First, it is questionable how valuable information found on the Internet can really be if all competitors have equal access to it. "... in a borderless, digital world ... geography

no longer defines economic space."[12] If information were the only production factor, and if face-to-face interactions did not underpin business relationships or the communication of knowledge vital to production, then falling costs of transmitting information would be crucial. As we have seen in part 1, however, the role of information is often exaggerated, and only routinized information is translated into bits and bytes. Although advances in ICTs are undoubtedly reshaping the economic landscape and affecting location decisions, they are by no means making geography irrelevant. Perhaps the point is best illustrated by the irony with which some herald the death of distance and the ubiquity of information as reasons why peripheral regions are fostering knowledge-intensive industrial clusters. In fact, knowledge clusters emerge not because information travels well, but precisely when it does not, when knowledge is embodied in the skills and expertise of local workers, in a firm's techniques, and in linkages between stakeholders. If distance were dead, firms would not cluster.

On-line information can be profitable if firms customize it to develop new products or new processes or if it informs them about successful practices, but the raw information itself may be of little economic value. The most profitable knowledge is that which has yet to become codified or commonly understood. In such cases, valuable knowledge will not be found or easily understood on-line but will be embodied in skilled workers, in company processes, and in regional linkages. This can occur in any industry, including resource extraction and transformation, and development strategies targeting high-tech or service industries will not necessarily be more successful.

There are best-case and worst-case scenarios regarding the Internet and economic opportunities. The best-case scenarios involve exploiting the Internet's potential as a medium for facilitating collaborations. It can also serve to promote and market ideas and products from producers in regions distant from markets. Yet the promise of the information revolution is exaggerated. Virtual firms in the areas of translation and architecture, for example, depend on knowledge acquired in translation and architecture schools as well as on information from client bases built in the real world. With all its potential, the Internet cannot eliminate the need to cluster.

---

12. C. McMillan, *Focusing on the Future: The New Atlantic Revolution* (Halifax: Council of Atlantic Premiers, 2001), 32.

Worst-case scenarios would see the Internet and other communication advances reshaping the economic landscape to the disadvantage of peripheral regions. Thirty years ago, regional authorities thought the less-industrialised Appalachia region of the eastern US suffered from a poor transportation infrastructure that shunned investments. With improvements to the road system, it became easier and cheaper for outside firms to ship out local natural resources. However, a better road and communication network is a double-edged sword that improves traffic in both directions. For smaller regions like Atlantic Canada, for example, improvements to the Internet and other telecommunications systems increase access to central markets but at the same time make it easier for firms in high-cost, central regions to export cost-sensitive activities to an area where real estate and wages are cheaper. The result has been increased opportunities, but not necessarily the manna of higher skilled, higher value-adding jobs. The intention here is not to spread pessimism, but to promote a guarded optimism in the face of claims that distance is dead or that the Internet, broadband, and the digital economy are the saviours of smaller communities.

***Myth 8:** Picking Winners*

One myth long recognized in regional development involves picking winners. Growth-pole theory of the 1960s and 1970s inspired efforts to plan regional economies around key "champion" firms picked by planners and policy-makers. However, enthusiasm for growth-pole theory waned with a growing concern over whether the intervention of bureaucrats and public officials created more harm than good in pursuing economic-development strategies centred on specific firms. In hindsight, high-profile efforts to lure firms to a region, such as Bricklin automobiles to New Brunswick during the 1970s and DeLorean to Northern Ireland more recently, highlight the lack of attention given to considerations of long-term private-firm location once initial tax abatements subside. Shaping location proved more difficult than bureaucrats and officials had presumed.

***Myth 9:** Fields of Dreams*

Debunking the previous myth led to a renewed faith in private markets, fuelling privatization in the public sector, and in pursuing regional development focused on entrepreneurship and private sector investments. Economic-development strategies in the 1990s revolved around two ideas. First, from local to national governments, the

challenge was to create a positive business climate or environment, namely, a reduction of the tax burden to attract private sector investments. Second, governments could play a small interventionist role by improving both hard infrastructure (roads, telecommunications) and soft infrastructure (education, training).

Attention to climate and infrastructure has led to another myth. The "fields of dreams" myth is named after the film that gave us the now famous line "If you build it, they will come." Instead of baseball diamonds in cornfields, policy-makers hope to attract firms and jobs by building positive business climates and infrastructure. In terms of innovation, and clusters in particular, the "fields of dreams" myth has fuelled regional-development efforts to build science and technology parks, providing state-of-the-art telecommunications, access to research facilities, and so forth. Such initiatives are important in promoting the development of regional industrial clusters, but the myth consists in believing climate and infrastructure alone are sufficient.[13] "Unfortunately, the world's landscape is littered with all too many research parks that have spawned little more than their own research, often because they were not joint ventures involving the public sector, private firms and the local community."[14] If regional-development efforts consisting of picking winning firms are an unlikely basis for creating and sustaining industrial clusters, passive efforts to improve business climate and infrastructure are just as unpromising. "What matters most is the exchange of knowledge and information; cooperation among governments, business and universities; and the forging of partnerships for mutual benefit. These relationships do not just happen. They thrive in countries that understand the process and act to strengthen them in the innovation system."[15]

***Myth 10**: Becoming the Next Silicon Valley*

Regional policy-makers are increasingly acknowledging myth 9, recognizing that successful and sustainable industries require concerted efforts beyond the laissez-faire approach of business-friendly tax regimes and infrastructure. The challenge, then, is to promote industries without picking individual firms. The question arises, can

---

13. "Government can and will support this process but, to be successful, actions to support clusters must emerge from the clusters themselves": see New Brunswick, *Greater Opportunity: New Brunswick's Prosperity Plan, 2002–2012* (Fredericton, 2002), 35.

14. C. Bekar and R. Lipsey, "Clusters and Economic Policy," *Canadian Journal of Policy Research* 3(1) (Spring 2002): 65.

15. Canada, *Science and Technology for the New Century: A Federal Strategy* (Ottawa, 1996), 4.

one change the location decisions of desirable industries once they emerge and mature when they have supplier and partner linkages anchoring them in a particular place?

The challenge is obviously daunting, and the rest of part 3 is an attempt to identify key ingredients. It requires identifying regional strengths and how well they are suited to both newly emerging industries and to existing and evolving ones. It also requires building regional innovative and learning capabilities that provide local firms and inhabitants not only with a fixed set of tools and skills but also with the ability to keep on learning and to adapt to changing markets and market demands. Market evolution may be impossible to predict, but the ability to adapt quickly to changing conditions increases a region's chances of sustaining advantages and seizing new opportunities.

In pursuing such strategies, regions must avoid myth 10. Instead of picking winning firms, this myth involves the belief that the environment and institutions of successful regions can be recreated elsewhere and so attract the same industries. (The Silicon Valley is commonly trumpeted as the poster child for regions hoping to build ICT-driven industries.) So deliberate are these efforts that regions like Portland, Oregon, southern Scotland, Kanata, and others sought to attract investment by marketing themselves as Silicon Forest, Silicon Glen, Silicon North, and so forth.[16] Fostering such industries is a challenge in itself, but there is a twofold myth operating here. First, once a critical mass of firms establishes itself in a region, it creates a virtuous circle by which new firms tend to emerge or relocate there (see part 1, subsection "Agglomeration, Creativity, and Learning"). Regions trying to establish a base in the same industrial sector will feel as though they are swimming against the current. Second, the conditions and institutions leading to the success of a region like the Silicon Valley are complex and locally specific. For these two reasons, it is easier for regions to pursue emerging niches suited to local assets and culture than to duplicate industries consolidated elsewhere.[17]

To summarize, building a framework for regional innovation policy means taking into account a number of pervasive myths that threaten to undermine its effectiveness. The suggestion here is not that the

16. Enthusiasm for the term has waned, but it remains in the vocabulary: see, for example, "Can Hub City Become Silicon Valley East?" *Moncton Times-Transcript*, 31 July 2002.

17. "[In a] move away from smoke-stack chasing, ... communities are now building on local strengths instead of attempting to transform themselves into a particular type of industrial town": see M. Skelly, *The Role of Canadian Municipalities in Economic Development* (Intergovernmental Committee of Urban and Regional Research, 1995), 8.

ten myths identified above should be dismissed out of hand but that each one be examined carefully. Myth 1: innovation and economic success should be linked with care. Myths 2 and 3: seeing innovations as new technologies deriving from scientific R & D neglects a much wider array of sources with the potential for a greater impact upon the regional economy. Myths 4 and 5: pursuing innovation policies should not overlook the role of imitation and the potential of existing traditional industries. Myths 6 and 7: excessive attention given to knowledge-intensive sectors and the Internet has hampered a balanced understanding of their role and potential for economic development. Myths 8, 9, and 10: regional-development efforts struggle between the mistaken beliefs that successful industries simply emerge under proper business climate and infrastructure, and that winning firms can be picked or competitive advantages duplicated. The following section highlights the need for successful innovation policies to look beyond these two limited views, while recognizing the importance of enlisting broader stakeholders in the process.

Regions, Institutions, Governance, and Culture: Incentives for Learning and Innovation

Why do construction firms or banks in various regions organize differently? Why do firms invest more in labour skills in one area, and more in machinery and technology in another? Why do savings, loans, equity, and venture capital vary by region as sources of financing? History, culture, and institutions are important in explaining regional practices and performances. They explain differences in how firms hire and train workers (community college and job fairs in North America versus apprenticeships in Germany), they explain health and retirement plans (firm-based in the US and Japan, government-based in Canada), and they explain how firms network and solicit partnerships, financial backers, and so forth.

Institutions here are understood in a much broader sense than simply as formal bureaucracies such as government agencies or universities. They include locally specific routines, practices, and norms that shape a firm's expectations on how business gets done. Institutions organize intangibles regarding market uncertainties. *Untraded interdependencies*[18] and *immaterial transactions*[19] describe how firms interact

18. M. Storper, *The Regional World* (New York: The Guildford Press, 1997).

19. M. Storper and A. Venables, *Buzz: The Economic Force of the City*, International Seminar on Economy and Space, (Faculty of Economics, Federal University of Minas Gerais, Ouro Preto, Minas Gerais, Brazil, 6–7 December 2001).

with each other in accordance with different and localized conventions. Simply put, what economists are increasingly recognizing is that firms respond not only to market constraints, but they also engage in local nonmarket transactions. Not all forms of collaboration are dictated by negotiated terms or contracts. That is why clusters play such an important role in the creation and diffusion of knowledge. Because of their proximity and constant interactions, firms develop trust and shared expectations that allow them to learn from the successes and failures of neighbouring firms, to lower transaction costs, to spread risks, and so forth.[20] And this occurs not only with supplier and client interactions but also with nearby competitors.

Atlantic Canadians often pride themselves on their willingness to help each other in times of need, such as when community members fall ill, lose their homes, etc. This spirit of mutualism is one of the institutions that, although not unique, contribute to the region's distinctive local character. Regarding the economy, regional institutions determine why and when firms collaborate instead of competing with each other, and why these arrangements differ regionally.[21] Just as institutions shape how firms collaborate in production, they also define how they collaborate in innovation. Institutions enhance the benefits and effectiveness of innovative activity.[22]

There have been several interpretations of why regional institutions organize intangibles differently from one region to the next — why some cultures and regions are more innovative than others. Social-capital theory[23] has examined regions like the Third Italy, pointing to civic traditions and institutions as the bases for trust and cooperation between firms. The Third Italy also served in the analyses of Italian economists Brusco, Bellandi, and Beccatini, who reprised the notion of *industrial districts* to describe new forms of company

---

20. Conference Board of Canada, *Collaborating for Innovation*, chapter 4 in particular provides a very good review of evidence of economic benefits as well as limits to collaboration.

21. "In order to develop an appropriate and effective competitive strategy, research institutes, agencies and provincial governments throughout the region must first identify and agree on key areas of strength or skills and assets in which to focus efforts": see A. Cornford, *Innovation and Commercialisation in Atlantic Canada* (ACOA, 2002), 40.

22. "There would be significant gains in Canada's innovation performance if we were to increase the level of collaboration of firms with their suppliers, customers and competitors, as well as with universities and government laboratories. About one-quarter of manufacturing firms have been involved in collaboration for innovation; this number could increase substantially": see Conference Board of Canada, *Collaborating for Innovation*, vii.

23. R. Putnam, *Making Democracy Work: Civic Traditions in Modern Italy* (Princeton: Princeton UP, 1993); E. Glaeser, D. Laibson, and B. Sacerdote, *The Economic Approach to Social Capital* (Cambridge, MA: National Bureau of Economic Research, 2000), Working Paper 7728.

organization and interaction.[24] The continued success of the Silicon Valley and other innovative regions depended less on the specific firms or the infrastructure (telecommunications, research labs) and more on the quality of the relationships between stakeholders, including entrepreneurs, researchers, and venture capitalists. According to the Conference Board of Canada, "Our findings imply that collaboration is only part of the reason that clusters exist. What may be more important to the success of a cluster is the presence of informal networks of people and organizations that offer easy and unintimidating access to the breakthrough thinking and leading-edge expertise that make innovation happen."[25]

"The channels and networks through which this information circulates are embedded in a social, political and cultural background, they are strongly guided and constrained by the institutional framework."[26] The OECD *Oslo Manual* thus acknowledges the crucial role of the social and political context in shaping how information and innovations diffuse and, it should be added, how they are produced. It also highlights the importance of institutions, although it should mention that institutions not only impose constraints; they also enable collaboration, help minimize risk, etc.

A key part of any innovation strategy is recognizing the institutions and practices specific to a region that are helpful in forging innovation-conducive relationships. These include mechanisms to promote collaborations between firms and academia as well as industry associations that help share knowledge between member firms (see also discussion in the following chapter).[27] Promoting such institutions and mechanisms is not a top-down prerogative of governments alone; it is also a bottom-up process involving firms, workers, and communities.

If stakeholders, institutions, and governance shape innovation success, so too do culture and values. Culture determines whether people or firms are more or less averse to risk, as well as entrepreneurship levels and where entrepreneurs seek financing (e.g., family

---

24. S. Brusco, "The Emilian Model: Productive Decentralization and Social Integration," *Cambridge Journal of Economics* 6 (1982): 167–84; M. Bellandi, *The Marshallian Industrial District*, Studie discussioni 42 (Scienze economiche, Università degli studi di Firenze, 1986); G. Beccatini, ed., *Mercato e forze locali: il distretto industriale* (Bologna: Il Mulino, 1987).

25. Conference Board of Canada, *Collaborating for Innovation*, 28.

26. OECD, *The Oslo Manual*, para. 71.

27. "Institutions matter. The institutions that guide and carry out science and technology, and the way they are arranged and function together, can either encourage or impede invention and the exchange of ideas": see Canada, *Science and Technology*, 15.

channels, financial institutions, markets). Culture also determines attitudes towards innovation and change.[28] The 1996 federal strategy promotes a stronger science culture, although its message[29] is more applicable to innovation in general.

This section reminds us that the sources of competitive advantage reside at the regional level. Unique to each region are culture, configurations of stakeholders, institutions that organize incentives, and governance structures that shape how stakeholders interact — all of which has a twofold implication for policy formulation. First, regional specificity means that best practices in one region can be emulated in another region only to the extent that both have similar institutions, culture, and governance. That is to say that because institutions, culture, and governance are locally specific and slower to change, regional-development proponents must be careful when embracing best practices from outside. At the same time, and this involves the second implication for policy formulation, the fact that best practices from outside a region are difficult to emulate presents unique opportunities for local configurations. In other words, there is much potential for innovation in recognizing and marshalling less-understood local strengths.

Collaboration and the Importance of Proximity

Linkages and collaboration are thus key features of the innovation process. As shown in part 2, motivations for collaboration are many and depend on the sector of activity. Those disagreeing that competitive advantages are regional in nature point to the fact that markets are global in scale and so therefore are opportunities for collaboration. Although this is increasingly true for some markets and activities, many innovation linkages are geographically specific. Collaboration in particular is affected by distance. The Conference Board of Canada's second report on innovation is based on 1999 data from Statistics Canada's *Survey of Innovation*, and it presents an excellent account of the role of collaboration in Canadian innovation activities. Although these data would be more useful if they were broken down by region

28. "Yet, perhaps the most important challenge for Atlantic Canada is to develop the common vision and the collective will to create a culture of innovation": see Cornford, *Innovation and Commercialization*, Executive Summary.

29. "Fostering a strong science [innovation] culture is everyone's business. It cannot be legislated by governments. It is the sum of all the actions, big and small, of all players in the economy. Science [Innovation] is both a mindset and a skill set. It is nurtured by attitudes that encourage curiosity, and value discovery, and are open to challenge and change": see Canada, *Science and Technology*, 34.

and sector, national-level data are also illuminating. For example, they show that firms have a strong preference for collaborating with consulting firms, universities, and government labs located within a hundred-kilometre radius. It is true that interfirm collaborations with suppliers, clients, and competitors involve US partners first because of market size and relative proximity;[30] however, firms closer to home are second.

Geographically Limited Industrial Clusters

Industrial clusters have been trumpeted as an excellent tool for economic development, and with good reason. Successful clusters are industries producing higher value-adding goods and services — industries that tend to sustain high-quality jobs over longer periods. At the same time, their workings and implementation have presented a serious challenge to regional policy-makers. The notion of clusters dates back to Alfred Marshall's industrial districts a century ago, later reprised by Italian economists in the 1980s, Michael Porter in the 1990s, and others. The need for proximity is the common thread in each version, but they differ as to the impetus leading to clusters and their underlying dynamics. Bekar and Lipsey provide a useful definition of clusters for our purposes: "We define a cluster as a large regional grouping of geographically proximate innovative firms, where those firms have strong linkages to local educational and research bodies, government laboratories, financial institutions, other elements of the business infrastructure, and to each other."[31]

Proximity to natural resources can draw similar firms to a particular region; one example is fish-processing plants. Other activities such as call centres group around human resources, areas where workers are skilled and less expensive. Yet the mere concentration of firms, whether processing plants or service operations, does not constitute an industrial cluster. If fish stocks run out or cheaper locations with equally qualified workers are found, the fish-processing plants and call centres may well relocate elsewhere. Hence, access to resources does not provide the geographic basis for sustaining industrial clusters. Instead, clusters present greater opportunities and are more sustainable when based on proximity and interdependencies between customers, competitors, suppliers, and other stakeholders.

---

30. Conference Board of Canada, *Collaborating for Innovation*, 27.

31. Bekar and Lipsey, "Clusters and Economic Policy," 63.

Whatever the industry and cluster, original locales sustain their competitive advantages even though the skills or techniques employed may eventually be imitated elsewhere. More difficult to imitate are the complex set of interactions between regional stakeholders by which knowledge is produced and evolves. In other words, importing or introducing a new idea may afford a firm and region temporary, or *static*, competitive advantages. *Dynamic*, or sustained, competitive advantages, on the other hand, depend on the repeated nature of interactions between users and producers, buyers and suppliers, partners and competitors.

When a region's competitive advantages lie in interfirm linkages, it is unlikely that individual firms will relocate if it means losing or rebuilding those relationships. This is especially true for firms where knowledge and innovation matter most.[32] Fish-processing or call-centre clusters emerge when firms come to depend more on linkages with nearby competitors, suppliers, and customers along the value-adding chain than on access to natural or human resources.

The importance of interfirm linkages is reflected in the attention given to supply-chain management and just-in-time delivery. Developers of enterprise software tend to cluster around major clients because IT systems supporting logistics, warehousing, accounting, forecasting, etc., require customized solutions and frequent support: managers planning evolving needs and technicians rolling out and supporting systems. For knowledge-dependent activities, good telecommunications and airport facilities can increase market reach. However, when knowledge is complex or requires constant interaction with customers and suppliers, seldom do we see virtual or other firms located far from major customers or suppliers. Certain forms of knowledge, especially in innovation-intensive industries, are "sticky" or "geographically limited."[33]

Clusters thus become prime real estate for regional-development policy. They grow from the concentration and linkages between suppliers and competitors, and they promote specialization and regional competitive advantages. Because spillovers from geographically limited (sticky) knowledge provide the impetus for firms to agglomerate and thus tap into the knowledge and experience of suppliers, competitors, local research institutions, and so forth, they ensure greater

32. D. Audretsch and M. Feldman, "R & D Spillovers and the Geography of Innovation and Production," *American Economic Review* 86(3) (1996): 630–40.

33. Bekar and Lipsey, "Clusters and Economic Policy," 63.

industry sustainability: firms will not relocate if it means giving up these linkages. Moreover, the uncertainty of knowledge production and industrial development[34] means that firms are more likely to agglomerate in regions that are successful at learning and producing new knowledge so that they can spread risks and capitalize on new opportunities.

Regional Innovation Systems

We now have all the pieces to the complex regional innovation puzzle. By debunking a number of the myths surrounding innovation, we have shown that it extends far beyond scientific R & D activities, depends greatly on interactions between a wide array of regional stakeholders, and has the potential to benefit much larger segments of the economy than is sometimes believed. Innovation stakeholders are not limited to federal government and private sector R & D labs; they also include broader participation by the private sector and the various levels of government (federal, provincial, municipal), labour and business organizations, education and training institutions, communities, etc.[35] How these stakeholders interact depends on formal and informal regional institutions and practices that shape expectations on how business gets done. This explains why firms in the same industry but in different regions approach collaboration differently.

National systems of innovation[36] and, more recently, regional systems of innovation (RSI) approaches have provided the most significant insights into this subject in the past decade, principally because of the holistic approach that has been taken. Innovations result from interactions within systems; they don't arise in isolation. "The 'National Systems of Innovation' (NSI) approach studies innovating firms in the context of the external institutions, government policies, competitors, suppliers, customers, value systems, and social and cultural practices that affect their operation. System approaches to innovation shift the focus of policy towards an emphasis on the interplay between institutions, looking at interactive processes in

---

34. See part 1 for a review of evolutionary economics.

35. "Innovation is as much regional and local as it is national. A climate for innovation is created by the leadership and drive of clusters of firms in an industry, along with the financial institutions serving them; responsive education and training institutions; local research bodies; boards of trade; municipal, territorial and provincial governments; entrepreneurs; and many others": see Canada, *Science and Technology*, 5.

36. See B. Lundvall (ed.), *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning* (London, Pinter, 1992) and R. Nelson, *National Innovation Systems: A Comparative Analysis* (Oxford, Oxford University Press, 1993).

the creation of knowledge and in the diffusion and application of knowledge. It has led to a better appreciation of the importance of the conditions, regulations and policies within which markets operate — and hence the inescapable role of governments in monitoring and seeking to fine-tune this overall framework."[37]

An innovation that may appear to have been developed by an R & D lab operating in isolation will in fact have been underpinned by the prior schooling of engineers and scientists, public sector investments in basic research, incentives for research funding and firm-academia collaborations, venture capital and IPO markets, cultural and entrepreneurial traditions, etc. RSI approaches paint a more complete picture by focusing on the numerous regional stakeholders involved, and on the institutions and incentives that determine risks, interact, collaborate, and compete. The 1996 Canadian federal science and technology strategy signalled a shift in this systemic approach.[38] "The linear approach to innovation has been abandoned. It was recognized that innovation is non-linear and has to be holistic. National innovation performance is a function, not only of the innovation in individual organizations, but also of the relationships and networks between institutions. This represents a shift in paradigm to a national system of innovation approach [...]"[39] In surveying the 2002 *Achieving Excellence* strategy in the next chapter, it becomes less clear whether the federal government has in fact accepted its own advice from the 1996 strategy. The "paradigm shift" may not be complete.

---

37. OECD, *The Oslo Manual*, para. 71 and para. 72.
38. "We must take a more deliberate approach to building the Canadian innovation system, by understanding how it functions, playing on its strengths and reducing its weaknesses, engaging all the participants, and getting the federal government's role right": see Canada, *Science and Technology*, 5.
39. Sulzenko, "Technology and Innovation Policy for the Knowledge-Based Economy," 285–305.

Chapter 6

Atlantic Canada Innovation Strategies

An Examination of Current Federal and Provincial Innovation Strategies

This section considers the recent two-pronged federal innovation strategy, released in 2002, in light of what has been discussed so far.[1] The first part, *Knowledge Matters*, focuses on skills and learning, while the second part, *Achieving Excellence*, concentrates more on science and research capacities.[2] After unveiling the strategy, Industry Canada launched a series of regional innovation summits across the country, which served as public consultations to guide a revised national strategy and to develop policies.

Nova Scotia in 2000 and New Brunswick in 2002 released ten-year economic development plans in which innovation was one of the major pillars. Nova Scotia's strategy followed province-wide consultations, while the New Brunswick strategy was designed to guide and inspire consultations. Newfoundland and Prince Edward Island have undertaken efforts to enhance their innovative capabilities, although they have yet to be detailed in comprehensive strategies like the ones set out by their Atlantic Canadian counterparts. This section assesses these strategies in light of the preceding discussion.

The Federal Strategy: Knowledge Matters

As highlighted in parts 1 and 2 of this study, innovations and skills are inseparable, a fact acknowledged by the federal strategy with its two-pronged approach consisting of skills and learning, on one hand (*Knowledge Matters),* and science and research, on the other (*Achieving Excellence*). One of the underlying premises of the strategy

1. Those interested in federal innovation policy over the last decade should read D. Wolfe's excellent survey, "So Much to Know? Innovation Policy for the Knowledge-Based Economy," in G. Bruce Doern (ed.), *How Ottawa Spends, 2002-2003* (Toronto: Oxford University Press, 2002).
2. Canada, *Knowledge Matters: Skills and Learning for Canadians* (Hull: Human Resources Canada, 2002); Canada, *Achieving Excellence: Investing in People, Knowledge, and Opportunity* (Ottawa: Industry Canada, 2002). See www.innovationstrategy.gc.ca.

is that today's economy, broadly speaking, is increasingly knowledge-based. The attention this gives the subject is warranted for the most part, as innovations, including ICTs, are permeating broad sectors of the economy and reorienting their production techniques. In more industrialized countries, what we have been seeing in recent years is another relative turn towards knowledge and skills. New production techniques made possible by rapid development and deployment of ICTs and new products from advances in life sciences have placed a premium on innovation and adaptability. So long as the pace of development and deployment continues at its present rate, firms and workers with higher degrees of adaptable skills will fare better. Governments, therefore, have a keen interest in ensuring that firms keep pace with evolving and competitive markets and that workers acquire the necessary skills.

Two caveats should be mentioned here. First, there has been a tendency to equate knowledge with ICTs and to prioritize those sectors to the exclusion of broader economic sectors for which innovation holds equal potential. It also turns attention away from the plight of workers in less innovative sectors. Priorities should thus include continuing education, or adult learning, as well as the proposals in *Knowledge Matters* to "encourage low-income and moderate-income Canadians currently in the workforce to participate in post-secondary education by 'learning while they earn.' " It would be a mistake, however, to limit education and training to postsecondary education. The federal government should also give incentives to workers and firms to provide on-site and after-hour training programs.

Second, "embracing the knowledge-based economy" has often led governments to focus on increasing education and training and to pay less attention to matching local, existing, and realistic industrial needs. For example, the goal set in *Knowledge Matters* is to increase annual master's and Ph.D. admissions by an average of 5 percent. Although these increases may be important for science-driven industries such as biotechnology and chemical industries, increases in master's and Ph.D.'s may be of limited economic benefit elsewhere. Census data reveal that in 1971 the number of university graduates matched the number of jobs requiring a university education. Between 1971 and 1991, however, the number of university graduates increased 140 percent and the number of jobs requiring a university degree only 40 percent.[3]

---

3. Y. Gingras and R. Roy, "Genuine Labour Shortage or Cyclical Phenomenon?" *Applied Research*, HRDC Bulletin 5(1) (Summer 1999).

The greater challenge, though, is to meet the skill requirements of industry. This may not mean increasing the number of university graduates as much as providing opportunities for apprenticeships and co-op programs, in high schools as well as universities, so that students can acquire practical skills and especially better labour market expectations. At present, employees must be constantly training, either on their own initiative or their employers', to keep pace with the changing demand for skills. Generally speaking, worker, firm, and regional-learning capabilities are as important as short-term skill requirements in a fast-evolving, knowledge-driven economy. Increasing the number of graduate admissions may go only part way towards recognizing this fact, but when it does strategies need to specify which sectors require employees with graduate degrees.

Another key imperative identified by *Knowledge Matters* is the aging population. Emphasing on youth and immigration, it notes that the 2001 census data suggest that the country and Atlantic Canada face important challenges as aging baby boomers retire. A low rate of natural increase, compounded by the out-migration of skilled workers, indicates that Atlantic Canadian governments should be actively involved in attracting skilled immigrants to the region. *Knowledge Matters* prioritizes the attraction of skilled immigrants, pointing out that provincial governments should do more in this area so that our strong and promising industrial sectors will have the skills they need. Educating and training skilled youth and then keeping them in the region are also a key challenge. Successfully integrating youth into the labour force requires a more concerted effort on the part of educational institutions and the private sector, namely, through apprenticeship programs.[4] Another key challenge, one that is only implicit in the strategy, is the loss of experience and skills caused by the retirement of key company managers and government officials.

The federal strategy is right to emphasize the need to collaborate with provincial governments, but it should also encourage community-level cooperation. There are, it is true, constitutional limits to federal participation at the local level, but in their strategies both New Brunswick and Nova Scotia call for federal participation in local, provincial, and federal economic-development partnerships. One such initiative involves provincial input in selecting projects for

4. "We need to have a serious examination of how to improve apprenticeship programs. There is a shortage of tradespeople in Canada, and it will worsen in the next few years. Canada is not prepared to deal with this issue under our current apprenticeship programming"; see Conference Board of Canada, *Performance and Potential, 2000–2001: Key Findings* (Ottawa, 2000), 11.

the Atlantic Innovation Fund. The coordination of this and other similar efforts by the federal and provincial governments can only improve their effectiveness. In the end, more effective government need not mean reduced intervention, only that interventions should be strategic and that they should facilitate and not duplicate or inhibit private investment. It also means improving the flexibility of federal and provincial programs to suit local needs.

The Federal Strategy: Achieving Excellence

Achieving Excellence identifies four main challenges. The knowledge-performance challenge is helping "more firms develop and market leading-edge innovations." It sets two major goals in meeting this challenge: (1) increase private and public investments in knowledge infrastructure to enhance R & D performance and (2) ensure that more firms benefit from the commercialization of knowledge. Four targets are set for 2010 — one focusing on raising venture-capital investments, another on increasing the commercialization of innovations, and two on R & D indicators.

The federal strategy aims to increase not only the production of research in universities and federal labs but also private sector opportunities arising from its dissemination and commercialization. There is great economic potential in producing and exploiting this knowledge, and yet, as we have seen throughout this study, innovation holds even greater promise for the economy if it is viewed as more than just the production and commercialization of science-driven research. Priorities outlined in *Achieving Excellence* include emphasizing on the "commercialization of world first innovations [with] investments in biotechnology, information and communications technologies, sustainable energy, mining and forestry, advanced materials and manufacturing, aquaculture and eco-efficiency." Priorities also include helping "SMEs assess and access global technology, form international R & D alliances, and establish international technology-based ventures." Because venture capital tends to be sectorally specific, increasing "the supply of venture capital in Canada" favours high-tech industries. And these opportunities are only the tip of the iceberg. There are, in addition, even greater possibilities for a wider array of sectors and firms.[5]

---

5. "Canada's challenge is to put our knowledge to work to create an effective and resilient innovation system that maximizes the synergies from activities performed at all levels and across all sectors and regions": see Canada, *Science and Technology for a New Century: A Federal Strategy* (Ottawa, 1996), 5.

Achieving Excellence focuses on Canada's science and research capacities, but it doesn't explain where in the federal strategy the objectives and measures are to unleash the larger potential of innovation. In 1996 *The Science and Technology Strategy* acknowledged the multiplicity of factors, sources, and stakeholders affecting innovation as an interactive and not isolated activity. In 2002 *Achieving Excellence* emphasizes dramatic scientific advances while neglecting the larger potential of incremental, less science-driven innovations.

The second major challenge identified by *Achieving Excellence*, the skills challenge, restates many of the important objectives of *Knowledge Matters*. The third challenge, the innovation environment challenge, consists of encouraging efforts to produce and adopt innovations by improving the tax and regulatory systems, as well as promoting entrepreneurship. By themselves, "climate-building" measures are inadequate, but they do serve to support other measures.

Community-based innovation challenges are perhaps the most important of the four sets of challenges. The goals identified here would have all levels of government cooperating to assist community assessments of "local strengths, weaknesses and opportunities" that help lead to the creation of "clusters of innovation." As discussed in the previous chapter, industrial clusters are the Holy Grail of innovation-led economic-development policies. The success of the Silicon Valley and the rise of places like Austin, Texas, have instilled in many depressed regions the hope of establishing dynamic, higher value-adding, export-oriented clusters. With new markets rapidly emerging and with the large number of Atlantic Canadian universities, many Atlantic Canadian communities are hoping to forge lucrative, niche economic activities of their own.

The strategy gives us only limited information on how clusters are created or sustained, but in its defence there is no blueprint for their creation or guarantees of their sustainability. Markets evolve and clusters can be moving targets. Defining clusters and mobilizing stakeholders and resources are complex and difficult issues, so it is puzzling why the strategy would be so rash as to set out specific objectives, such as ten "internationally recognized technology clusters" by 2010. How was this figure arrived at, by what criteria will it be measured, and which regions will benefit from these cluster-facilitating initiatives?

The degree of specialization and the concentration of firms, suppliers, producer services, specialized workers, and financial capital that underpin clusters are all to the advantage of larger centres. This should not exclude the creation of clusters in Atlantic Canada, but it does require more regional thinking in the areas of achieving a critical mass and key interfirm and business-academia linkages. It also means moving beyond parochialism to consider regional networks centred around Atlantic Canada's larger cities. "The deployment of broadband, particularly for rural and remote areas," another priority of *Achieving Excellence*, helps reduce some constraints imposed by distance, but it does little to address the need for knowledge-driven clusters to agglomerate. This means that smaller communities must increase linkages with larger provincial centres, and that interprovincial urban linkages and economic coordination must be improved.

The Federal Strategy: The Atlantic Innovation Fund

After unveiling a national innovation strategy that increased funding to federal research institutions largely absent from Atlantic Canada, the federal government created the Atlantic Innovation Fund (AIF) to address the imbalance. The AIF provides $300 million of federal funds to be invested in two phases over five years. Recipients of the first phase and applications for the second were announced in the summer of 2002. Of the 195 applications in phase one, 47 projects worth $155 million were approved.

The AIF was created as a temporary remedial measure, although innovation is clearly a continuing process and challenge. Hence the success of the AIF and any need to extend its life will hinge on two main issues. The first is a concern, voiced loudly by the Atlantic Institute for Market Studies (AIMS), that government funding should not usurp the role of the private sector. The second issue concerns the broad nature of innovation.

Regarding the first issue, the criticism is valid only to the extent that the AIF funds viable projects that normally would have attracted private investors. In defense of the AIF, economics gives us two important instances of market failure where government funding plays a crucial and legitimate role. First, basic research is considered a public good. It supports valuable applied research, and yet because it often yields low returns on investment or cannot easily be supported by individual firms, it attracts insufficient private investment. Evidence shows that federally funded research labs play important roles in the diffusion of knowledge among science-driven industries in Canada

and the US. But with the relative dearth of federal research labs, funding, and collaboration in the region, there is a legitimate need to fill the void by funding similar cutting-edge research with a potential for commercialization, at least until a more equitable distribution of federal lab activity is achieved. The danger of "picking winners" is minimized by a process that is rigorous, involves numerous stakeholders, and maintains an arms length relationship with politics.

The second instance of market failure involves inadequate capital markets. Because venture capitalists and other investors rely on an intimate knowledge of a region and the industry and firms they finance, nascent Atlantic Canadian firms, such as in biopharmaceuticals, have greater difficulty attracting outside investment. In turn, this provides fewer opportunities for venture capitalists in Montreal, Ottawa, Toronto, and Calgary to get acquainted with Atlantic Canadian markets and firms, and may restrict their investment in the region. The problem is particularly acute for smaller firms.[6] Initiatives such as the AIF can thus play a strategic role by funding viable projects for which private investment is inadequate.

The second issue affecting the success of AIF investments concerns its focus on science-driven research activities. Federal minister Claudette Bradshaw says the projects demonstrate "what we are trying to achieve with the Atlantic Innovation Fund – to stimulate partnerships with universities, research centres and industry leaders with the goal of moving more of our cutting-edge research from the labs into the marketplace."[7] In moving research from labs to markets, we see the AIF filling a gap created by the absence of federal research labs and venture capital markets. As argued throughout this study, however, scientific research is only one of several sources of innovation, one that is clearly not as important for less science-based industries. Thus, the AIF can only be part of the region's innovation strategy. Moreover, stimulating partnerships requires a concerted effort to improve academia-business relationships, because the extent of knowledge spillovers from research will depend as much on the quality of those relationships as on the research.

---

6. One study found that while government assistance was an important source of funding for firms of all sizes, venture capital was an important source of funding for only medium- ($5 million to $25 million in sales) and large-size firms (more than $25 million): see A. Riding and B. Orser, *Beyond the Banks: Creating Financing for Canadian Small Business Owners* (Toronto: Wiley, 1997).

7. Quoted in the *Moncton Times-Transcript*, 4 July 2002, A3.

In sum, criticism of public investment such as that provided by the AIMS serves to highlight the risk of "picking winners" or the threat of displacing private investment. However, such criticism fails to consider warranted government intervention when addressing market failures, such as inadequate capital markets and providing public goods such as basic research. Insofar as scientific research is important to innovation, the AIF does play an essential role on both counts, although longer-term strategies should look to correct and not just compensate for market failures. This means establishing an equitable number of federal labs in the region, particularly in fields that complement local strengths, as well as improving access to private venture-capital markets. The latter is doubly important because venture capitalists not only fund risk; they also provide recipient firms with much-needed expertise, something the AIF may not be able to do as effectively.

Nova Scotia's Opportunities for Prosperity[8]

In 2000 Nova Scotia unveiled a ten-year economic growth strategy. Emphasized in the strategy are business climate, infrastructure, innovation, labour force, investment, exports, and regional capacity. The Nova Scotia strategy formulated the results of province-wide consultations into four principles, two of which attracted our attention. One recognizes the need for collaboration, for government to work with businesses, other levels of government, and "with communities, citizen groups, and labour to ensure they participate in economic growth." The other advocates strengthening industrial clusters in both "foundation" industries as well as emerging ones.

The strategy states, "Nova Scotians have known for generations that education equals employment."[9] Unfortunately, education can also equal migration in terms of the brain drain or spatial mismatches between the supply of and demand for skills. Human capital investments alone are insufficient if they are not matched with local industrial needs.

The strategy seeks a balance between what it calls "foundation industries" and those with "exciting growth opportunities." Foundation industries are "those based on our ocean resources, our land resources, agriculture, and tourism and culture," while growth opportunities are identified as the digital economy, energy, advanced manufacturing, learning, and life sciences.

---

8. Nova Scotia, *Opportunities for Prosperity* (Halifax, 2000).
9. Ibid., 5.

On the whole, Nova Scotia has a sound approach to innovation. At the outset the document states, "Innovation in all our industries is the key to expansion and growth of the economy."[10] That is a recognition that the potential of innovation extends to all sectors of the economy; it is also a recognition that research activities and inventions have a more limited potential when compared with commercialization. The latter places a greater premium on collaboration and on the "quick adoption of new technology and good design practices." Greater commercialization, collaboration between stakeholders, and concerted efforts to build a culture of innovation "together make up our innovation system, and international evidence show the best strategy is to assure that the whole innovation system is working, *not just fragments of it.*"[11]

New Brunswick's Prosperity Plan[12]

New Brunswick unveiled a ten-year (2002–12) prosperity plan outlining its economic development strategy, of which innovation is one of four "building blocks." The others include investing in people, creating a competitive fiscal and business environment, and building a strategic infrastructure. The strategy recognizes that "innovation is not just about the 'high technology' sector."[13] It also stresses the importance of building a dynamic community-level enterprise culture as well as "partnerships between governments, business, workers, communities, universities and other learning and research institutions."[14] The document suggests three key ingredients for planning prosperity, including the need to forge strategic partnerships to compensate for the lack of a critical mass while taking advantage of the province's smaller size.

Three implementation strategies are proposed. The first consists of both economic diversification and clustering. "The two work together because successful diversification will only occur by recognizing our core competencies as a province and building on them."[15] However, clustering is about the specialization, not diversification, of economic

---

10. Ibid., 16.
11. Emphasis added.
12. New Brunswick, *Greater Opportunity: New Brunswick's Prosperity Plan, 2002–2012* (Fredericton, 2002).
13. "The adoption of knowledge-based technologies can now be found in virtually all sectors of the economy, from fish processing to mining to government services." Ibid., 8.
14. Ibid., 1.
15. Ibid., 34.

activity. Both strategies have their merits, but how they can be simultaneously pursued is not made clear. Clarity is also lacking in the explanation of how "diversification helps foster the innovative culture so necessary for success in today's knowledge-based economy."

New Brunswick's innovation strategy sets out four cornerstone priorities. First, eNB.ca is the government's coordinated strategy to embrace the ICT revolution in government, business, learning, and infrastructure. Second, "total development" presents a strategy to target higher value-adding activities along the processing and transformation stages. This is perhaps where innovation holds the greatest promise, as it recognizes the potential for product and process improvements across stages and economic sectors. The third goal is simply called "R & D," although it clearly encompasses much broader elements. There are calls for R & D tax credits, increased private R & D investments, and greater exploitation of federal R & D programs. At the same time there are other measures, such as building dynamic clusters, building "stronger collaborative linkages amongst governments, private sector, and universities,"[16] and holding innovation summits. This second group of measures considers the larger benefits of innovation to the economy as a whole without paying particular attention to R & D. New Brunswick would have done well to look at Nova Scotia's strategy, which deals with similar issues but under the much broader rubric of innovation systems. The fourth objective calls for the increased adoption and commercialization of technology, acknowledging the dual nature of technology as tools and know-how.

The most promising part of the strategy pertains to "innovation clusters" as the products of linkages between universities, business, and government. It proposes a "strategic clustering initiative," which includes proposals to identify and map the potential for cluster growth, "engage stakeholders in establishing cluster networks, both within and outside the province," develop strategic plans, and examine the supportive role of governments. The strategy acknowledges the fundamental role played by communities in shaping and driving economic development, and urges a coordinated approach to economic development involving a broader range of regional stakeholders. Although the director of Business New Brunswick's Innovation Branch argues that "competition between Atlantic provinces and communities is a healthy thing,"[17] Alan Cornford says the opposite may

16. Ibid., 29.

17. Interview with Michel Gauvin, director of innovation, Business New Brunswick (Fredericton, New Brunswick, April 2002).

be true: "Competition within the region may only weaken Atlantic Canada's ability to develop a SCA [sustained competitive advantage], however, because without cooperation in this initiative, the region lacks the critical mass of population, skills, industry and dollars to be competitive on the world market."[18]

Proposing a Global-Regional, Instigator-Stakeholder (GRIS) Innovation Framework

The Global-Regional, Instigator-Stakeholder (GRIS) framework proposed here builds upon many of the elements introduced in parts 1, 2, and 3 of this study. It recognizes the growing importance of global markets as a source for imports of intermediate goods and value-added exports and at the same time views the region as the source of competitive advantages. It considers the myriad stakeholders involved in the process of innovation and, given that the process cannot succeed on its own, identifies the stakeholders that also play pivotal roles as instigators — i.e., those who promote the synergies that underlie globally competitive innovative regions.

First Dimension: Stakeholders

The GRIS framework emphasizes the geographic aspect (firm, region, nation, globe) of the linkages connecting innovation stakeholders.[19] There are thus two dimensions to consider: the nature of stakeholders and the geographic scale of activity. Figure 1 illustrates the gamut of various stakeholders involved, with the innovating firm acting as pivot for the innovative process. This suggests a key, though not exclusive, role played by innovating firms in commercializing the knowledge and innovations produced by the system. The framework emphasizes that the success of innovating firms hinges on the quality of the other stakeholders and of the linkages between them.

Two factors are noteworthy when considering these linkages. First, linkages involve both market and nonmarket transactions. Market transactions are those where funds are exchanged, such as in the hiring of consultants or when undertaking joint ventures. Nonmarket transactions can mean sharing facilities, workers, and information through networking, all done with no money changing hands but

---

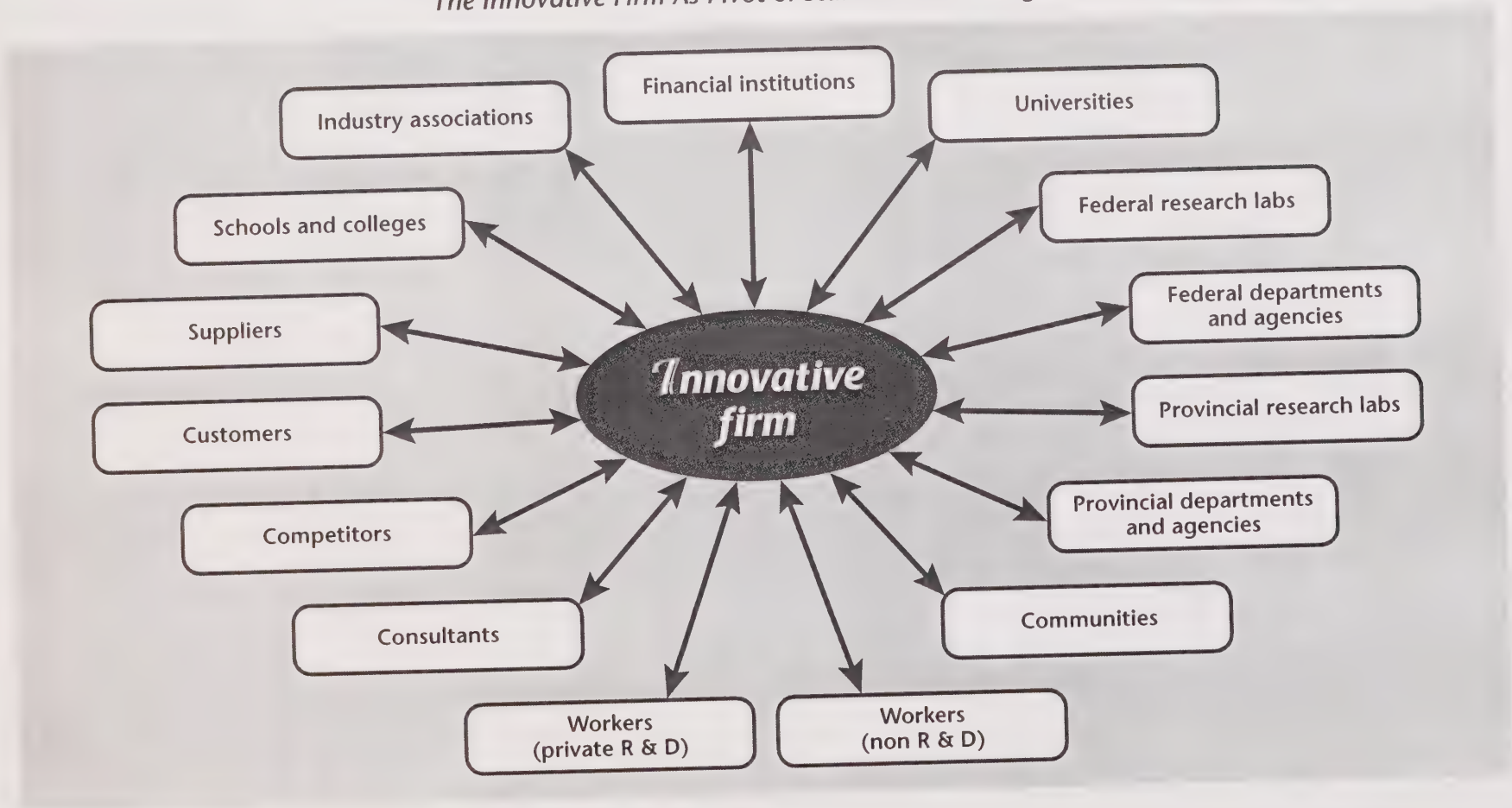
18. A. Cornford, *Innovation and Commercialization in Atlantic Canada*, report prepared for the Atlantic Canada Opportunities Agency (Moncton, 2002), 40.

19. In presenting the framework I drew upon literature about NSI (Lundvall 1992, Nelson 1993) and global city regions (Scott 2000), my intention being to emphasize the crucial geographic dimensions of the linkages between stakeholders.

Figure 1

The National Systems of Innovation Stakeholders

The Innovative Firm As Pivot of Stakeholders Linkages



in the expectation of present or future reciprocity or mutual benefits. Suppliers invite clients to witness production in order to refine their processes and to improve client products. The second factor to consider concerning linkages is that they are all important, not just those between other stakeholders and innovative firms but the ones between other stakeholders as well. In other words, the quality of the innovative system also depends on linkages between governments, academia, schools, and communities.

Some participants involved in the innovative process act as both stakeholder and instigator. This means that they are not only a source of *knowledge production* fuelling innovation, but they must also play an active role in *forging relationships* between stakeholders, including themselves. In other words, all listed stakeholders are involved in the innovation process, but a few of them have the resources and the ability to push the process forward. Instigators include the innovative firm as well as local, provincial, and federal agencies and departments together with schools, colleges, universities, and communities. In the appendix, the instigators are listed first, followed by the innovation stakeholders whom they mobilize and with whom they forge relationships.

Second Dimension: Geography

The second dimension of the framework is the geographic scale of activity (see figure 2). The firm is at the centre because it is regarded as the basic unit of economic activity. Firms undertake some daily activities in relative isolation (firm level); others are performed at the regional level, where linkages and proximity to other stakeholders are important. These involve labour, suppliers, competitors, institutions, etc. Less frequent but also important are activities at the global scale.

Delineating boundaries between firm, regional, and global scales causes some difficulties. First, the firm is viewed as the basic unit of economic activity, but we know there are departments and decisions competing within firms that shape their innovative potential. How firms allocate resources and organize operations is quite important but less frequently discussed in systems of innovative approaches. Second, regarding the firm as self-contained units obscures various levels of decentralization, including multinational corporations with subsidiaries in many countries. A flexible view of the firm that includes divisions and subsidiaries is therefore required.

Figure 2

Scale of Activity

The Firm As the Basic Unit of Scale

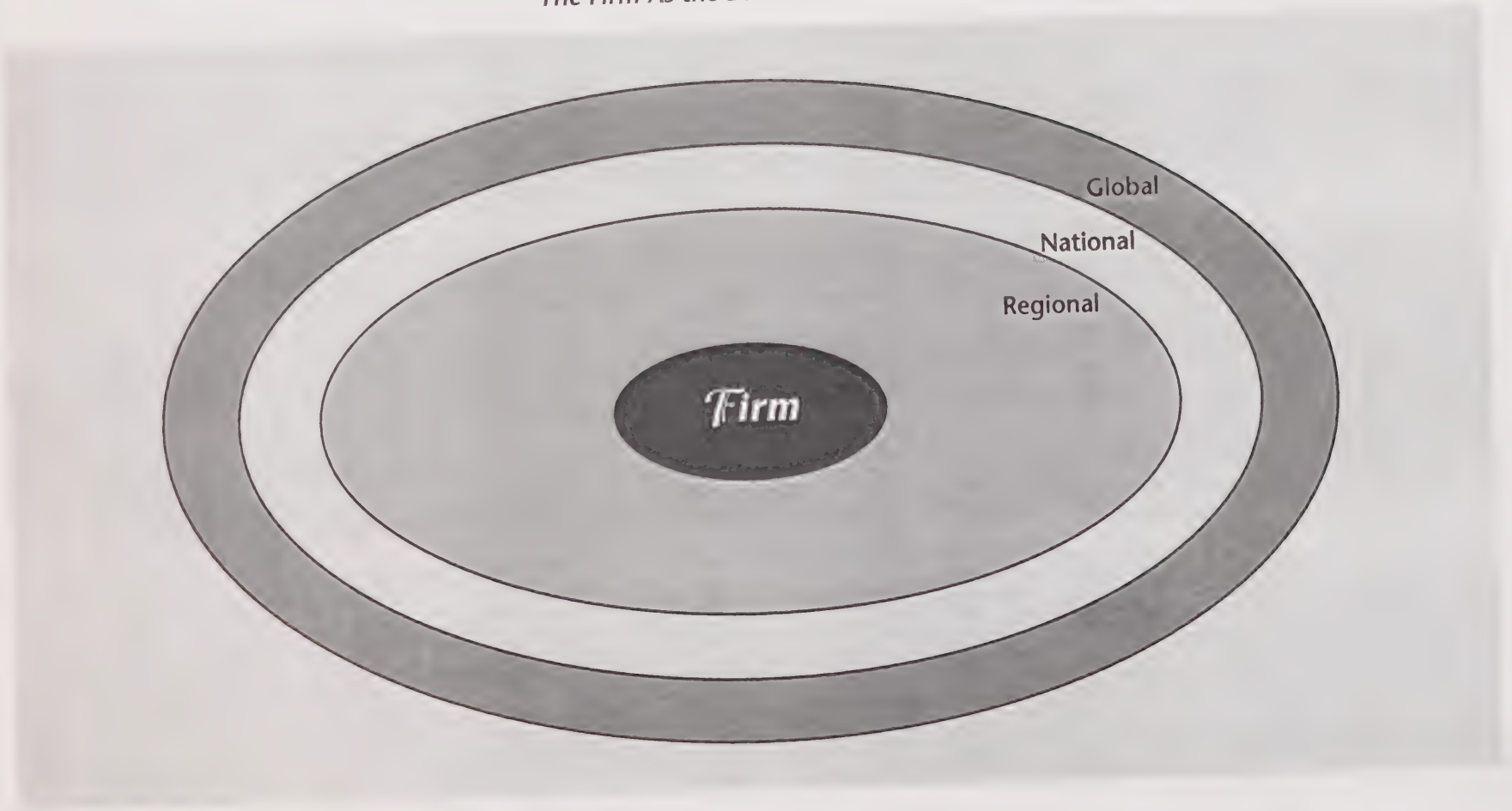
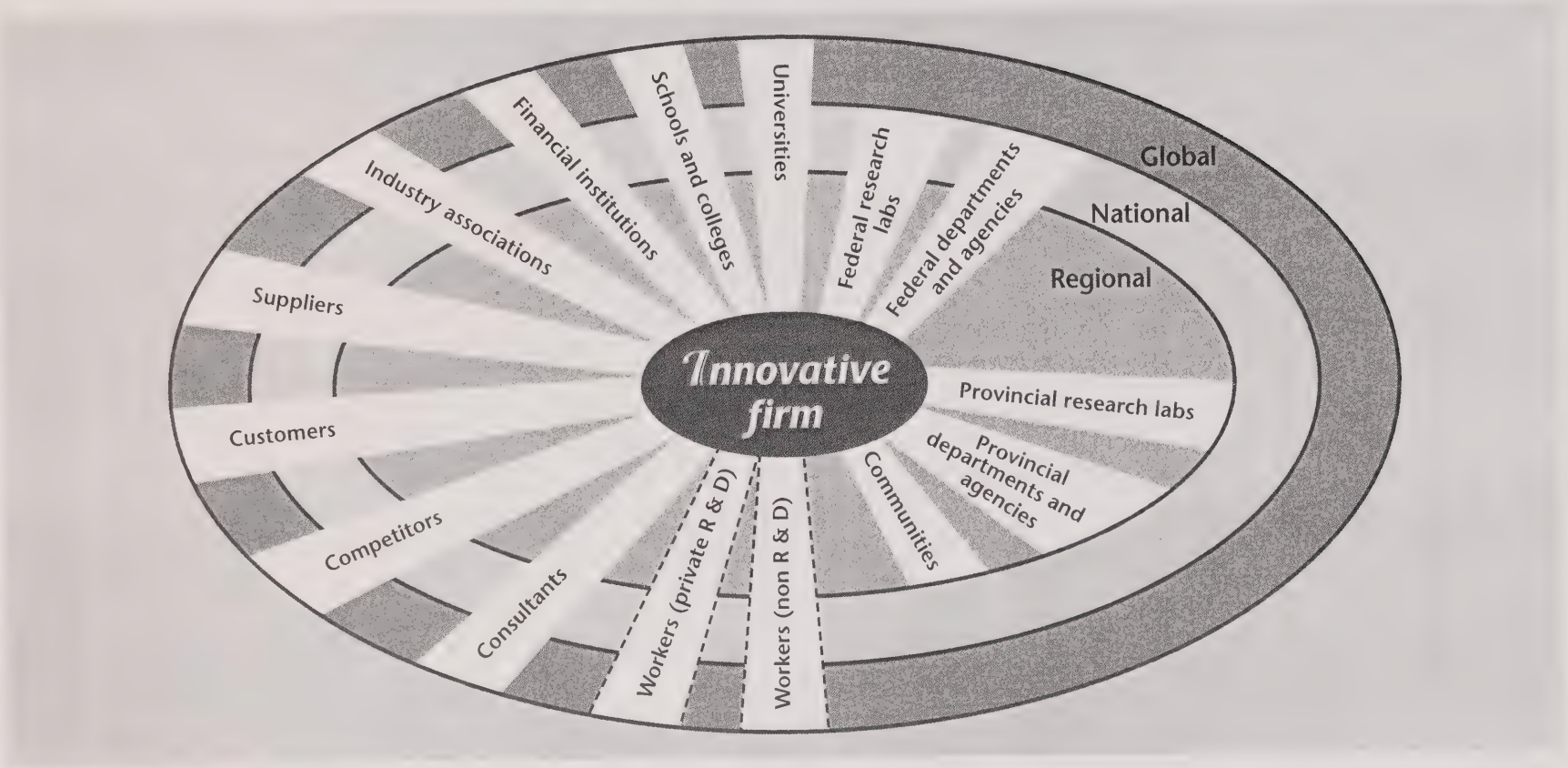


Figure 3

GRIS Framework

The Stakeholders and Geography of the Innovation Process



Note: The vectors for both types of workers are dotted to indicate that their potential for innovation depends on efforts that are both internal (as employees) and external to the firm (e. g. as labor pools educated in regional schools).

Third, what is seen as constituting a region can vary: Metro Halifax, Labrador, and Atlantic Canada are all regions of different orders. We know that many industries cluster because of the benefits of proximity to innovation and production, but what constitutes proximity (metro area, Atlantic Canada, northeastern seaboard) will vary by industry because of the unique characteristics of each. Hence strategies require that existing formal political units (municipal, provincial, and federal governments) pool their efforts with informal governing institutions (e.g., industry associations, chambers of commerce) industry by industry.

Fourth, globalization has increased the interconnectedness between regions, but there remains a distinction between local innovation and production systems in which firms collaborate and interact intensely and global markets where they import resources and intermediate goods, export value-added goods, and interact less frequently. The geographic nature of clusters attests to this important distinction between the regional and the national/global. The national level is significant because of nation-wide social, fiscal, and monetary-policy instruments supporting the system. Industrial policies, including those pertaining to innovation, are an important responsibility shared by the federal government, although these policies work best when tailored to industry and regional needs. Therefore, national-level institutions and agencies play an important supportive and facilitative role, but the sources of competitive advantage are rooted in regions.

Figure 3 combines both stakeholder and geographic dimensions to produce the GRIS framework. The innovative firm becomes the central agent of the innovation process, with stakeholder linkages extending outward from the firm to the regional, national, and global levels, according to their activities. It is important to recognize that the relative weight of each stakeholder will vary depending on the industry. For example, biopharmaceutical firms may depend relatively more on linkages with local university research, while telecommunication firms may rely relatively more on global competitor and supplier linkages. The shape of the stakeholder vectors jutting out from the innovative firm (see figure 3) will thus be wider or narrower at each scale depending on the industrial sector. More research is needed to determine the relative weight of each stakeholder, at each scale, and for each industry in Atlantic Canada. This would be a fruitful next step in ascertaining the region's innovative capabilities and potential. In the appendix that concludes this study, we provide an overview of how the framework works, by applying it to the Atlantic economy as a whole, while considering the scale and variety of policy measures required.

Conclusion

This study has attempted to answer three questions regarding innovation in Atlantic Canada. How is innovation important to the region's economic development? How successful has the region been at innovating? What can the region do to improve its performance? The scope of this research and the evolving nature of the topic do not lend themselves to definitive answers; however, our hope is that we have put the subject on a sound footing.

Part one surveyed major concepts, debates, and research surrounding innovation, knowledge, human capital, R & D, productivity, clusters, and spillovers. Enthusiasm for these concepts is largely warranted, but it has also obscured a better understanding of them. Part 1 thus served to remind us of the importance of linking innovation to economic growth, which should be the main policy objective. Otherwise, there is a danger of pursuing innovation for its own sake. For instance, improving the region's science base through increased research funding is one thing, but the real question is how will this affect industrial performance. Which industries are present in the region that would benefit from this research, and how will they benefit? And what mechanisms and channels are being promoted to ensure the diffusion of research and knowledge? How important is this research as a source of innovation for given industries, and are there other sources whose promotion would be more effective in improving the performance or market share of local firms? These are important questions, and they tell us that there is more to success than simply fixing targets for research spending.

Part 1 also reminded us that the link between innovation and growth is still not fully understood or appreciated. Such a link needs to be established with care and depends partly on the conceptual framework we use. For example, we saw that neo-classical economics emphasizes production functions in linking innovation and productivity gains, but those interested in clusters in emerging niche markets are better served by evolutionary economics and what it has to say

about technological trajectories and how valuable knowledge does not travel well.

Because we increasingly believe that innovation is important to growth but are still struggling to assess its complex nature, those studying innovation tend to use and develop proxy indicators to measure innovative activity (e.g., the number of innovations, R & D spending, and patents), even though they know that such indicators are imperfect. Researchers are therefore continually developing new indicators in an attempt to get closer to the core dynamics. As a result, indicators and data on innovation should always be interpreted with a degree of caution, something we have tried to be mindful of in our attempt to measure a very complex set of phenomena. Moreover, indicators should especially be avoided as policy targets. Gross expenditures on research and development (GERD) are meant to reflect the degree of innovative effort and intent, not necessarily innovative potential and success. It is true there are correlations between GERD and growth, but that is not to say that one causes the other. In other words, because certain OECD countries spend more on R & D does not mean that they are wealthy because they spend more.

R & D plays an important role as a broad set of research and experimental design activities, both in the lab and on the shop floor, and firms and governments should be strategic in their R & D efforts. However, we cannot afford to fixate on R & D at the expense of ignoring the broader dynamics and potential of innovation for all sectors of the economy. Studies in the last ten years are increasingly rejecting R & D as a master key that unlocks a linear innovation process, seeing it instead as one of several pieces to the innovation puzzle.

The primary objective of part 2 was to evaluate from an empirical perspective the state of innovation in the manufacturing industry in Atlantic Canada. This subject has raised a lot of interest because of the economic benefits often associated with innovation. We drew on two national surveys from Statistics Canada, the *1999 Workplace and Employee Survey* and the *1999 Survey of Innovation*, to demonstrate that innovation implies much more than the simple commercialization of an idea. The major value of these surveys in comparison with previous ones lies in the fact that they allowed us to substitute actual innovation rates for traditional indicators of innovation. We were therefore able to show that firms in the Atlantic provinces are, as a whole, actively involved in the race to innovate in the manufacturing industry.

We also went some way towards clarifying the issues surrounding the question of whether Atlantic Canada firms are at the heart or on the fringe of innovation. Early on in our study, we were puzzled by the numbers from the WES which showed that the region has the second-best innovation performance in Canada. According to the survey, 50 percent of Atlantic Canada firms were innovative. In order to qualify this percentage, which many thought was surprisingly high, we consulted additional data on basic indicators of innovation. In turn, indicators such as the weak tendency to integrate new technologies, the small number of patents issued to the region's entrepreneurs, the low percentage of funds and staff allocated to R & D, and the modest efforts of employers to train their employees forced us to reconsider this initial rate of innovation. The conclusion we reached was that Atlantic Canada firms were neither at the heart nor on the fringe of innovation, but somewhere in between. During our analysis, several sectors were recognized for their excellent innovation performance. In particular, the finance and insurance sector proved to be very dynamic, both in Canada and Atlantic Canada. The overall winner, however, was the manufacturing industry because of the extent of its innovation efforts and rate of success. The *1999 Survey of Innovation* somewhat met our expectations by allowing us to lower a little our assessment of the performance of Atlantic Canada firms. Through its focus on the manufacturing industry, it revealed that the region's firms ranked third among Canadian provinces. This is still a very good performance, though, especially since this industry is among the most innovative, with innovation rates of 79.7 percent in Prince Edward Island, 77.1 percent in Newfoundland and Labrador, 76.6 percent in Nova Scotia, and 73.9 percent in New Brunswick. In addition to being more than respectable in itself, this performance compares quite favourably with that of manufacturing firms in four selected European countries.

Clearly if the region's firms are distinguishing themselves by their high rates of innovation and their propensity to introduce more new products or processes that are considered as world or Canadian firsts, there must be some very attractive economic benefits. The study of nine distinct impacts stemming from the introduction of new products or processes rapidly demonstrated that innovation has much more than financial benefits. From the subjective evaluations of the entrepreneurs surveyed by the *1999 Survey of Innovation*, we especially noted the importance of innovation in maintaining a firm's relative

position as well as in increasing its market share, productivity, and employment level. In the Atlantic region, the benefits of innovation are extremely important to firms, which are often faced with financing problems, productivity delays, and relatively limited markets.

Atlantic Canada's manufacturing firms have had to make a considerable effort to achieve the success they enjoy in the world of innovation and at the same time to earn economic benefits from it. Our analysis demonstrated that the region's innovators tend to draw from a wide range of information sources (clients, suppliers, management and production staff, universities, etc.) in their pursuit of innovation, thereby creating a favourable climate for the emergence of new products or processes. In this regard, Atlantic Canada firms have also demonstrated a sustained effort in three basic activities related to innovation: R & D, integration of new technologies, and particularly the training of employees. When we took a closer look at the various steps involved in innovation, the additional efforts of innovators did not go unnoticed. As well, the region's firms are especially inclined to make collaboration agreements to pool their resources with other private or public entities, which is a model to be emulated by non-innovators in the region.

We also highlighted the government's interest in these numerous initiatives, as well as the risks incurred by innovators. The establishment of the Canada Foundation for Innovation in 1997 is the clearest example of the federal government's commitment to innovation. As has been noted, however, the CFI largely ignored the Atlantic region, which forced the more recent establishment of the Atlantic Innovation Fund (managed by ACOA). The government's involvement in the race to innovate is most welcome, a feeling confirmed by the large number of innovative manufacturing firms in the region that have taken advantage of government assistance programs. Nevertheless, a lot of time, energy, and financing will be needed if these firms are to overcome the many problems raised by innovation.

In this regard, most Canadian entrepreneurs involved in this process are concerned with the costs associated with innovation. For Atlantic Canada firms, the lack of venture capital and R & D funds continues to limit their work in this area. Finally, in order for any innovation to be realized, it has to be nourished by a favourable climate. On this point, a particular problem faced by the region's entrepreneurs has been a shortage of workers with critical skills, although

collaboration with other entities, especially universities, has enabled them to compensate for the lack of human resources and the difficulty in accessing knowledge.

This review of innovation in the manufacturing industry in Atlantic Canada has shown us that from an empirical point of view the region's firms are doing just fine. They are among the leaders in the integration of new technologies and the introduction of world firsts, which together explain the lure of innovation for dynamic and prosperous economies. But given that the concept of innovation necessarily implies instability, change, and adjustment, firms need, with the support of governments, to continue working with enthusiasm, determination, and imagination, because the benefits of innovation invariably go to the fiercest competitor.

Building on the theoretical groundwork of part 1 and the empirical analysis of part 2, part 3 had two broad objectives. The first was to weed out a number of myths about innovation and to identify key elements that underpin successful regional innovation strategies. The second objective was to assemble those elements into a framework, examine how they interact with each other over space, and suggest a variety of policy initiatives and other measures that can strengthen the region's innovation network.

Pursuing effective innovation strategies requires a sober understanding of the innovation process, and so part 3 began by dispelling a number of popular myths. Among the things we have learned in implementing innovation strategies are that R & D is not the only source, new technologies are not the only outcome, and new industries are not the only sector affected by innovation activities.

As well, we now understand that the value of knowledge depends not on the extent of its use in production but on its scarcity. We often hear it said that we must have "knowledge-intensive firms" with "knowledge workers," but what does that mean? Consider the manufacturing of personal computers, the scanning of photographs into digital format, and the development of Web sites. When these products and services were first introduced, they garnered high prices for PCs and higher wages for those who knew how to scan images and build Web sites. Although the knowledge underpinning these activities just remains as sophisticated in absolute terms, it has now become so widespread that those possessing this knowledge can no longer demand the same high prices or wages they once did. IBM has shifted away from making PCs because the manufacturers of "clones"

are able to make them cheaper. Photo-scanning services are inexpensive because the same function is available on home computers. And the knowledge used to build Web sites is now so common, and made easier with user-friendly, site-building software, that Web developers can only charge high fees for their services if they use software (e.g., Flash) that isn't widely available.

If the value of knowledge depends on its scarcity, then what makes it scarce? Although ICT improvements have made it easier and cheaper to diffuse some forms of knowledge, valuable forms of knowledge typically do not travel well. In other words, when knowledge is "sticky" in time, firms and managers need to be the "first to know." And when it is sticky in space, their physical presence improves its quality. For example, despite claims that the Internet and ICTs have eliminated distance (another myth that was also discussed), company headquarters and firms in the financial sector still cluster in large and expensive metropolitan areas like New York, London, and Toronto. The value of being where the knowledge is produced and exchanged first-hand clearly outweighs expensive real estate costs.

For workers, the wage potential of skills depends not only on their quality or on years of education but on how many other people possess these skills. Some skills are acquired formally at schools and colleges, but many are gained through experience (learning-by-doing) — by perfecting one's tasks and by finding better ways of doing them. This highlights the important productivity gains from exploiting the experience of workers as well as by tapping into tacit knowledge not formally taught in schools. The attention given to knowledge management in the business world reflects this growing concern with translating the tacit knowledge and skills of workers into the production process.

On the downside, regional-development efforts to attract higher-end economic activities (where the value of knowledge is contingent on time (being the first to know), such as in the financial sector) represent a difficult challenge given that the impetus to agglomerate already exists elsewhere. On the upside, there is enormous potential for wealth and growth in activities where knowledge is sticky in space. Regions develop competitive advantages and local strengths not only from natural resources but also from a skill base and industrial experience — from expertise specific to the region. Regions also have a unique configuration of firms that interact among themselves (networks of partners, competitors, clients, suppliers, producer serv-

ices) and with local institutions, both formal (government agencies, financial and education systems) and informal (values, norms, and conventions that determine how business is done). Firms cluster to access resources or markets, but more importantly they cluster in many sectors to tap into local expertise and knowledge embodied in workers and firms and in the linkages between them. This provides the basis for successful industrial clusters and cluster strategies.

Therefore, economic success isn't just the result of targeting high-tech industries or increasing the knowledge intensity of firms or improving their research capacities. The challenge is to recognize and improve the quality of the linkages between the numerous regional stakeholders by which local knowledge is diffused and to match those linkages with local strengths and competitive advantages. Achieving this will improve a region's learning and innovation capabilities as well as its long-term ability to adopt, adapt, develop, and commercialize valuable ideas. Success means keeping pace and moving ahead of the learning curve, and this applies to all firms across all sectors, to traditional as much as to high-tech industries.

Finally, success does not happen by itself. Although regional-development efforts have rightly moved away from picking winners, and we should be weary by now of attempts to replicate Silicon Valley or create "technopolises," efforts limited to creating positive business climates and providing infrastructure are also doomed to fail. This is not to recommend top-down interventionist measures by the federal government alone but rather a concerted effort by a broader base of innovation stakeholders that include communities and local firms. The federal government does play an active role in the process (implementing science and technology policies, funding basic research, and encouraging applied research), but scientific R & D activities are only the tip of the innovation iceberg. What is needed is a much broader view of innovation and the various pieces to the puzzle. The GRIS framework introduced in part 3 is an attempt to circumscribe these numerous stakeholders, to determine which ones play special roles as instigators in coordinating innovation efforts and the types of initiatives they can pursue.

Appendix

A Global-Regional Framework for Atlantic Canada

Table 1

Instigators[a]: Innovative Firms

Stakeholders[b]	Measures[c]	Type[d]	Scale[e]
Firms	**Organization.** A firm's innovation potential reflects its ongoing efforts to examine and reorganize internal production and management systems, including inventory and quality control systems.	Management	Firm
Workers, schools, universities, communities, governments	**Training.** Provide job-specific training to workers to enhance skills and to match them with company needs, organization, and production processes.	Human resources	Regional, but also national and global if training is abroad.
Non–R & D workers	**Knowledge management.** All workers have skills, expertise, and knowledge gained through experience that have an important productivity potential but may lie dormant if companies fail to recognize them or use them effectively. Just as important as training in providing new skills, companies need mechanisms to identify, assess, and unlock existing worker skills and expertise and apply them to production.	Management	Firm
Non–R & D workers, schools, universities	**Recruiting.** Many worker skills are acquired before joining a firm. Companies have strong reasons to interact with education institutions. For example, firms benefit from summer employment or school-year co-op programs that can facilitate recruiting and training. Firms also have incentives to participate in defining immigration priorities so as to communicate skill shortages and industry needs.	Human resources	Mostly regional, given the relative immobility of workers, but in some industries skilled workers from other parts of Canada and the world are needed.

All workers	**Big picture.** In many medium- to larger-sized firms, employees may work in somewhat isolated divisions, with little knowledge of other divisions, their needs, and prerogatives. Employees who have worked in or know the work of other divisions can use their knowledge and skills to innovate, improving production processes from a better understanding of company operations, as well as anticipating and solving bottlenecks. This suggests that innovation success may depend on a balance between the specialization of jobs and tasks (greater division of labour, including R & D workers) and maintaining a broad perspective of company operations for all employees.	Management	Firm
All workers	**Labour relations.** In some European countries, labour unions are more actively and regularly involved in negotiating company directions. Because a firm's competitiveness hinges not only on costs but also on productivity, labour relations are seen by both industry and unions as opportunities to target and reward labour-productivity gains. Higher productivity can raise wages without increasing real operating costs. Hence firms have incentives to work with labour to tailor training programs, implement new technologies and reduce turnover rates, which represent lost productivity through loss of experience.	Management	Regional and national, depending on the structure of labour and industry organization.

[a] Instigators are stakeholders in the innovation process that play an additional role as catalysts — synergizers that mobilize or coordinate other stakeholders' efforts.

[b] Stakeholders are all the people and organizations involved in the innovation process. As with all systems of innovation, linkages between stakeholders are bidirectional: the process is not linear but produces feedback loops. In other words, stakeholders (e.g., workers) not only shape outcomes but are affected by and learn from them.

[c] Measures are policy instruments and other means by which instigators can motivate stakeholders or the linkages between them.

[d] Type refers to the type of measure, the likely company or government department responsible, source of funding, etc.

[e] Scale refers to the geographic scale on which the proposed measures and interventions are best carried out.

Stakeholders	Measures	Type	Scale
R & D workers, universities	**Recruiting.** For those industries reliant on scientific R & D as a source of innovation, the recruiting, training, and retention of scientists and engineers are a priority. Networking with university and professional schools, including apprenticeship opportunities for students, provides an important channel for recruiting. So too is active involvement in setting immigration priorities to recruit scientists and engineers in areas where there are important shortages.	Human resources	Engineering and science graduates are often more mobile as workers, so efforts should combine regional training and recruiting with recruiting at the national and global levels.
R & D workers	**R & D** includes, but is not limited to, scientific activities. For most firms, then, R & D consists of search-and-improve activities outside the confines of labs and on the wider shop floor. Thus the potential of R & D activities applies to all industries. Improving these capacities involves a broader conception of R & D and of R & D workers. Many innovative firms have dedicated units that act as a central nervous system that is linked to all departments and is responsible for problem-solving activities and implementing new ideas and technologies. R & D workers thus not only develop new ideas; they improve a firm's absorptive capacities — they are antennae and filters, innovation vigils that keep track of industry and market changes. This is done by monitoring codified knowledge from patents or specialized journals, but also informal and tacit knowledge from personal information networks.	Management, human resources	

Consultants	**Competitive intelligence.** Because of their role in understanding market, industry, technological, and other changes, consulting firms provide important knowledge that can complement internal R & D and absorptive capacities, or can fill the void for those companies who cannot operate internal divisions.	Management, R & D	The more that firms serve regional markets, the more important the geographic proximity of consulting firms tends to be.
Consultants	**Implementation.** Perhaps more important than monitoring market, industry, and technological trends, consulting firms play critical roles in sharing their familiarity and experience with new ideas and technologies that firms consider acquiring. This experience is key to the successful implementation of innovations.	Management	
Users/clients, workers	**Interfirm linkages.** In many industries, interactions with users and clients are a major source of innovations. Better knowledge of their needs and requirements can improve product design and production processes. Firms benefit from having workers interact or even based with users and clients, and from having mechanisms to incorporate their feedback.	Management	All scales, depending on the location of major client and users, but mostly regional if interactions are to be constant.
Suppliers, workers	**Interfirm linkages.** Interaction with suppliers can increase innovativeness in two main ways: firms can learn from suppliers and thus improve their production processes, and firms can improve the quality of their products by helping suppliers improve theirs.	Management	All scales, depending on the location of major suppliers, but mostly regional if interactions are to be constant.

Stakeholders	Measures	Type	Scale
Competitors, universities, suppliers, customers, federal and provincial research labs	**Joint ventures, partnerships, etc.** Collaborative arrangements are an excellent way to spread risks during the early stages of product development, share expertise for mutual benefit, etc. They help smaller firms pool resources and achieve a critical mass in terms of financial capital or personnel for projects for which they may not have internal capacities. This is particularly important in Atlantic Canada. Firms also need to consider when other stakeholders are more important for collaboration (e.g., competitors during early product development).	Management, R & D	Mostly regional as proximity is important to collaboration — moreso for some stakeholders (e.g., universities) than for others.

Table 2

Instigators: Workers

Stakeholders	Measures	Type	Scale
Schools, firms, universities, communities, governments	**Training.** The successful development and implementation of innovations hinge on the skills of R & D and production workers, on managers, and on how well skills match new technologies. All stakeholders benefit from better-trained workers. Broader training can improve the general skills and well being of workers and concerns workers, communities, and governments. Industry-specific training increases workers' productivity and the ability of a region to develop successful clusters, and so concerns workers, industries, regional governments, and communities. Firm-specific training is of immediate interest to workers and firms. Workers and their representative bodies should thus work in collaboration with other stakeholders, depending on the nature of the training, to ensure not only greater skills and wages but safer, better-quality jobs and industry sustainability.	Union dues, firms, workers, government programs, use of community and public facilities	Regional
Firms	**Labour relations.** The competitiveness of firms depends on both costs and productivity. Higher wages when labour productivity also increases is not a losing proposition for firms. Labour unions should thus negotiate appropriate training programs with firms and the implementation of new technologies to better match worker skills. This increases productivity gains and in turn reaps higher wages and industry sustainability.		Regional and national, depending on industry and labour structure.

Table 3

Instigators: Industry Associations

Stakeholders	Measures	Type	Scale
Firms, provincial and federal governments	**Promoting linkages.** As representative bodies, industry associations act as catalysts to promote member networks and linkages with other stakeholders such as governments. They provide mechanisms for collaborative efforts that underlie innovation. This rubric is short, but it signals a broad set of synergizing activities ensured by industry associations.	Networking	Regional and national
Firms, workers, provincial and federal governments	**Information services.** Industry associations provide valuable information enhancing innovative potential. Information can pertain to labour markets, government programs, industry trends, and so forth.	Information	Regional and national

Table 4

Instigator: Schools and Community Colleges

Stakeholders	Measures	Type	Scale
Workers, firms, communities, governments	**Training.** The essential role played by educational institutions in the innovative process is providing initial and ongoing training to workers — present and future. The challenge is finding the right balance between general and specific skills — a balance that increases worker adaptability and versatility — and the expertise needed for industry specialization. Finding such a balance requires close cooperation with other stakeholders, including communities and local school boards, provincial governments for funds and curricula, workers in need of skills upgrading, and firms requiring a better fit between their skills demand and the region's supply.		

Table 5

Instigators: Universities

Stakeholders	Measures	Type	Scale
Workers, firms, schools, communities	**Education and training.** Like schools and community and vocational colleges, one of the main roles of universities in the innovative process consists of providing initial and ongoing training to current and future workers. The quality of undergraduate programs affects the innovative potential of the wide array of industries that recruit them. Strong graduate science programs improve the potential of local firms reliant on scientific R & D, either through collaborations with research centres or through the recruitment of graduates.	Tuition, government, private endowments	Regional, national, global
Workers, firms, schools, communities	**Education network building.** Greater collaboration with the school system and private industry can better match the supply and demand of skills. It can help fill gaps in general education and training, something that schools and the private sector are less able to do. It can also increase the likelihood of retaining local talent and of attracting and retaining outside talent.	Networking	Regional, national, global
Federal and provincial governments and labs	**Basic research.** In addition to education, universities are an important source of basic research. Some basic research holds immense medium- or long-term potential, but it is not pursued by private research because of uncertain short-term dividends and applications.		Regional, national, global
Firms, R & D workers, federal and provincial labs	**Research network building.** Industry-academia collaborations can ensure a mutual understanding of needs, assets, and expertise. Industry provides a source of both funding and problems for research.	Commercialization and technology transfer offices, joint ventures, privately funded endowments, chairs	Mostly regional but also national

Universities, provincial and federal governments	**Centres of excellence** are one means to formalize the collaborative arrangements mentioned above. Pursuing such strategies requires collaboration between firms, universities, and all levels of government in order to better reflect regional strengths and potential and, hence, the potential success of the centres of excellence.	Federal, provincial, and private investments	Regional, national
Universities, provincial governments	**Cooperation.** Because scale and specialization matter to innovation, and because they represent particular challenges to the region, cooperation between the region's universities is an important means to ensure a critical mass of research personnel and expertise. This critical mass and expertise can help attract and improve the performance of research institutes and centres of excellence, and may avoid awkward situations where nearby universities compete over the same research centre of excellence. This may not undermine the region's ability to attract public research dollars, but it may prove costly attracting large private sector investments.	Atlantic Provinces Education Foundation, Maritime Provinces Higher Education Commission, and other more frequent and less formal cooperative mechanisms	Regional

Table 6

Instigators: Communities

Stakeholders	Measures	Type	Scale
Innovative firms, industry associations	**Marketing.** Municipal governments and local economic development commissions need updated inventories of existing firms by subsector. These would fill market information gaps in local strengths and critical mass that can foster or attract competitors and suppliers, thereby fuelling innovation and further clustering.	Municipal or local economic development marketing activities	Regional, national, and, with the assistance of provincial and federal governments, global
Innovative firms, federal and provincial governments	**Program information.** Municipal governments and local economic development commissions can provide one-stop access and information for innovation-related programs and initiatives by all levels of government.	Information services	Regional
Innovative firms, federal and provincial labs	**Incubators.** Provide incubator facilities for product development, especially for SMEs that may not be able to afford in-house facilities. Assistance should not be limited to facilities but should include access to technical, managerial, and export-market expertise.	Land, construction, conversion costs partly subsidized, operations paid through user fees	Regional
Innovative firms, workers, federal and provincial governments	**Training.** Encourage firms, especially SMEs that may not have in-house facilities, to access community centres or other municipal facilities to provide firm-specific skills training. Build upon existing community access centre programs, which target more Internet learning.	Subsidize the purchase or upgrading of basic equipment (computers, audio-visual)	Community, regional

Communities, provincial governments	**Regional integration and cooperation.** Because innovation is a highly collaborative activity that is shaped by distance, community size becomes an important factor. Smaller towns often do not have research centres or a critical mass of other producers for firms to collaborate with in innovation. This compels smaller firms and communities to think regionally and to improve cooperation and pool resources to achieve a critical mass. It means that a closer integration with larger Atlantic Canadian urban centres helps innovative potential. Even our bigger cities lack the critical mass of large metropolitan areas. This relative disadvantage can be compensated for by better integration with surrounding localities and improved cooperation between Atlantic Canadian cities, as well as between their provincial governments. Competition should be between companies, not communities.		Regional cooperation mechanisms
Schools, firms, federal and provincial governments	**Curricula.** Communities, through the actions of local school boards, have a keen interest in the curricula set by the education system. Skills and interaction with local firms, including practical experience such as through apprenticeship programs, shape future innovativeness.	School curricula	Community, regional
Firms, universities, provincial and federal governments	**Techno parks.** In a survey of Canadian municipalities, 35 percent were involved in providing telecommunications infrastructure, and 7 percent funded research. This suggests that there is a direct role for municipalities in pursuing such initiatives, including technology park strategies, but two caveats should be made. First, strategies must be clear about existing and targeted sectors and how they will benefit. Second, the mixed record of technology parks suggests that success hinges more on fostering quality relationships between stakeholders than on infrastructure alone.	Facilitating network linkages, Infrastructure, research funding	Regional

Table 7

Instigators: Provincial Governments, Departments, and Agencies

Stakeholders	Measures	Type	Scale
Provincial R & D labs, universities	**Funding basic research** by department and agency labs as well as by universities.	Departments, research councils	Regional
Communities, federal government, firms	**Support** local community economic-development agencies through funding, information, research, and logistics. Collaborate with communities, the federal government, and firms to establish strategic directions regarding innovation that reflect local strengths and priorities. Initiatives include industry and regional SWOT studies, and facilitating the pooling of resources between smaller areas and their greater integration with larger urban centres.	Information, research support, funding	Regional
Communities, firms, universities, research labs, industry associations	**Networking.** Promote interfirm linkages and collaboration between firms and research centres: both are main sources of innovation. Initiatives include providing information and research to identify potential key partnerships, as well as mechanisms to facilitate collaboration, either directly or through industry associations. The challenge to create interfirm linkages and collaboration with research centres is particularly difficult for smaller firms and in smaller locales, so examine means to facilitate the pooling of community resources and integration with larger centres.	Research, collaborative mechanisms	Regional
Communities, firms, federal government	**Infrastructure.** Collaborate with communities, firms, and the federal government to ensure infrastructure projects reflect regional strengths and opportunities. The Atlantic provinces are known for their quality information and communications infrastructure. Ensure that all communities have access to state-of-the-art infrastructure.	Federal and provincial infrastructure programs, joint partnerships with firms	Regional

Communities, workers	**Training.** Community access programs should not be limited to increasing the number of computer or Internet users, but should be accompanied by efforts to increase the number of developers. Becoming a user can only reap some of the opportunities of new technologies. From experience gained in community access programs and for those already proficient in new technologies, training and other programs can help community members turn ideas and new skills into marketable skills and commercial ventures.	Community access programs	Regional
Schools, universities, firms	**Training.** Promote collaboration between firms and community colleges and universities to encourage firms to increase ongoing training opportunities for workers and to help education institutions to better match ongoing training needs.	Training, networking	Regional
Schools, communities, universities, firms	**Education.** Work with all stakeholders to ensure provincial education systems and curricula find the right balance between general skills for well-rounded citizens and specific training and apprenticeships for more productive workers.	Education spending	Regional
Firms	**R & D tax incentives** that recognize the considerable variety of research and experimental design activities that constitute R & D.	Tax incentives	Regional
Firms, communities, research labs, federal government	**Clusters.** Innovation plays an important role in sustaining industrial clusters. Dynamic clusters involve the concentration of firms in physical space in order to be close not only to natural resources or cheap labour but also to research centres and especially other firms (suppliers, clients, and competitors) with which they regularly collaborate. Cluster sustainability and growth depend on the quality of other stakeholders, the quality of the relations between them, and the quality of regional institutions that facilitate collaborations. Provincial governments play a pivotal role in quarterbacking efforts among stakeholders because of their regional perspective. However, the success of cluster strategies will depend on collaborations between municipalities, other provinces, and the federal government.	Network building	Regional

Stakeholders	Measures	Type	Scale
Firms, research labs	**FDI.** Greater efforts should be made to attract foreign direct investments, particularly in fields with regional strengths and growth opportunities. FDI represents an important complement to the cluster strategies described above. Strategies to attract subsidiaries based on the region's low wages will not ensure rising incomes or industry sustainability. FDI efforts should thus insert themselves into a broader economic development strategy that sees industry concentration as the first of several steps. Subsequent steps involve moving up the value-adding chain, for which innovation plays an important role. FDI efforts should target firms that suit the region and that provide opportunities in terms of mutual expertise and knowledge. In summary, if initial FDI strategies hope to establish a critical mass of similar firms in the region, efforts ultimately need to focus on attracting suppliers and clients, as well as subsidiaries that will not only engage in production activities but also commit to developing innovative products and processes, including research and building local linkages.	FDI	National, global
Firms, communities, federal government	**Trade missions.** Encourage greater participation from companies and municipal officials in trade missions abroad. Objectives should include securing new markets for imported and exported goods, creating opportunities for partnerships and alliances, and recruiting talent (as does the Irish government).	Trade missions	Global

Table 8

Instigators: Provincial Research Labs and Councils

Stakeholders	Measures	Type	Scale
Labs, R & D workers	**Basic research.** Provincial research labs undertake basic research that supports applied research important to industries dependent on scientific research.	Department and agency labs	Regional
Universities	**Basic research funding.** Provincial labs and councils can also support basic research indirectly by funding universities and other basic research.	Provincial research councils	Regional
Firms, labs, and councils	**Network building.** Research labs and councils not only undertake and fund basic research, but they also play a leadership role in building collaborative networks between academia, government departments, and the private sector. Networks help establish common strategies and achieve synergies that allow stakeholders to benefit from each other's strengths and expertise. For labs, collaborative networks help disseminate research, improve its quality, and recruit researchers. For smaller firms, collaborating with government labs and other research centres is one way to compensate for the lack of internal R & D capabilities.	Network-building initiatives	Regional
Firms	**Incubators.** One offshoot of network-building efforts includes arrangements between firms and federal labs to use facilities as incubators. Interacting with experts is as important as the physical plants themselves.	Commercialization, user fees, and other remunerative arrangements	Regional

Table 9

Instigators: Federal Government, Departments, and Agencies

Stakeholders	Measures	Type	Scale
All	**Innovation strategy.** The federal government has the best vantage point from which to oversee the coordination of efforts and priorities in shaping a national innovation strategy. The regional innovation summits held across Canada in the spring and summer of 2002, culminating in a national summit in the fall of 2002, were ideal venues to consult the wide array of local stakeholders. They should be repeated regularly, such as every five years, to reflect changing priorities. Anything more frequent may not see enough changes to warrant the cost of organizing them. Instead, permanent consultation mechanisms should be instituted to continuously gather stakeholder feedback. In addition, more frequent sector-specific consultations, including summits, should be held at regional and national levels, since broad, national innovation strategies do not reflect the challenges and sources of innovation specific to each industry. The continued success of these consultations will hinge on the extent to which the process and outcomes reflect local concerns and feedback.	Departments (e.g., Industry Canada, HRDC), with consultation mechanisms	Regional, national
Federal R & D labs, universities	**Funding basic research** by department and agency labs. In 2002-03, NSERC will invest $678 million in research and training to support 9,000 students and 8,700 researchers. It also encourages more than 1,000 Canadian companies to invest in university research. In 2002-03, SSHRC will invest $143 million in researchers and graduate students, some of whom study knowledge management, diffusion, and relationships.	Departments, research councils	Regional, national
Communities, provincial governments, firms	**Local development.** Collaborate with provincial governments and help local community economic-development agencies with information and research support. Work with local stakeholders to establish strategic directions regarding innovation that reflect local strengths and priorities. Initiatives include industry and regional SWOT studies.	Research and information support	Regional, national

Communities, provincial governments, firms, universities, research labs	**Networking.** Promote interfirm linkages and collaboration with research centres, which are main sources of innovation. Initiatives include providing information and research to identify potential key partnerships, as well as mechanisms to facilitate collaboration, either directly or through industry associations.	Research, collaborative mechanisms	Regional, national
Communities, firms, provincial governments	**Infrastructure.** Collaborate with communities, firms, and provincial governments to ensure that infrastructure projects reflect regional strengths and opportunities.	Infrastructure programs, joint partnerships	Regional
Firms	**R & D tax incentives** that recognize the considerable variety of research and experimental design activities that constitute R & D.	Tax incentives	National
Firms, provincial governments	**Trade missions.** Encourage greater participation from companies and municipal officials in trade missions abroad. Objectives should include securing new markets for imported and exported goods, creating opportunities for partnerships and alliances, and recruiting talent (as does the Irish government).	Trade missions	Global
Universities, research labs, firms	**Intellectual property rights.** Improve the IPR system, encourage firms and federal research labs to make better use of patenting mechanisms and incentives, and encourage the commercialization of innovations through university technology transfer offices.	Regulatory	National
Universities, firms, research labs	**Hiring.** Facilitate the recruiting of foreign scientists, engineers, and other skilled workers who are key to the competitiveness of Canadian private and public R & D. This issue is particularly important in Atlantic Canada. Measures include recruiting efforts akin to trade missions and improving the accreditation process of skilled workers (with the cooperation of professional trade bodies).	Immigration	Global

Stakeholders	Measures	Type	Scale
Firms, universities	**Financial capital.** The provision of financial capital through federal bodies like ACOA, AIF, and BDBC is an important element of the region's innovation strategy. Key to its success lies in the technical, financial, and managerial expertise that accompanies capital. Experts in all three areas should be enlisted in the project evaluation process; however, it is crucial that their expertise also be made available to recipients.	Financial capital and expertise	Regional, national

Table 10

Instigators: Federal Research Labs and Councils

Stakeholders	Measures	Type	Scale
Labs, R & D workers	**Basic research.** Federal research labs undertake basic research that supports applied research important to industries dependent on scientific research.	Department and agency labs	Regional, national
Universities	**Basic research funding.** Federal councils can also support basic research indirectly by funding universities and other basic research.	NSERC, SSHRC	Regional, national
Firms, labs, and councils	**Network building.** Research labs and councils not only undertake and fund basic research, but they also play a leadership role in building collaborative networks between academia, government departments, and the private sector. Networks help establish common strategies and achieve synergies that allow stakeholders to benefit from each other's strengths and expertise. For labs, collaborative networks help disseminate research, improve its quality, and recruit researchers. For smaller firms, collaborating with government labs and other research centres is one way to compensate for the lack of internal R & D capabilities.	IRAP and other network-building initiatives	Regional, national
Firms	**Incubators.** One offshoot of network-building efforts includes arrangements between firms and federal labs to use facilities as incubators. Interacting with experts is as important as the physical plants themselves.	Commercialization, user fees, and other remunerative arrangements	Regional

Bibliography

Adams, J. *Comparative Localization of Academic and Industrial Spillovers.* Cambridge, MA: National Bureau of Economic Research, 2001. Working Paper 8292.

———. *Endogenous R & D Spillovers and Industrial Research Productivity.* Cambridge, MA: National Bureau of Economic Research, 2000. Working Paper 7484.

Adams, J., E. Chiang, and J. Jensen. *The Influence of Federal Laboratory R & D on Industrial Research.* Cambridge, MA: National Bureau of Economic Research, 2000. Working Paper 7612.

Adams, J., E. Chiang, and K. Starkey. *Industry-University Cooperative Research Centres.* Cambridge, MA: National Bureau of Economic Research, 2000. Working Paper 7843.

Arrow, K. "The Economic Implications of Learning by Doing." *Review of Economic Studies* 29 (1962): 155–73.

———. *The Limits of Organization.* New York: Norton, 1974.

Arthur, W. B. "Competing Technologies, Increasing Returns, and Lock-in by Historical Events." *Economic Journal* 99 (1989).

Atlantic Canada Opportunities Agency (ACOA). *Atlantic Innovation Fund: Framework Paper,* www.acoa.ca/e/financial/aif/framework.shtml (consulted 20 February 2002).

Audretsch, D., and M. Feldman. "R & D Spillovers and the Geography of Innovation and Production." *American Economic Review* 86 (3) (1996): 630–40.

Autor, D. *Wiring the Labor Market.* Cambridge, MA: National Bureau of Economic Research, 2000. Working Paper 7959.

Autor, D., F. Levy, and R. Murnane. *The Skill Content of Recent Technological Change: An Empirical Exploration.* Cambridge, MA: National Bureau of Economic Research, 2000. Working Paper 8337.

———. *Upstairs, Downstairs: Computer-Skill Complementarity and Computer-Labor Substitution on Two Floors of a Large Bank*. Cambridge, MA: National Bureau of Economic Research, 2000. Working Paper 7890.

Baily, M., and R. Lawrence. *Do We Have a New E-conomy?* Cambridge, MA: National Bureau of Economic Research, 2001. Working Paper 8243.

Baldwin, J. *The Importance of Research and Development for Innovation in Small and Large Canadian Manufacturing Firms*. Ottawa: Statistics Canada, Analytical Studies Branch – Research Document, 1997. No. 11F0019MIF, No. 107.

———. *Innovation, Training, and Success*. Ottawa: Statistics Canada, Analytical Studies Branch – Research Document, 1999. No. 11F119MIF, No. 137.

Baldwin, J., G. Gellatly, J. Johnson, and V. Peters. *Innovation in Dynamic Service Industries*. Ottawa: Statistics Canada, 1998. No. 88-516-XPB.

Baldwin, J., T. Gray, and J. Johnson. *Technology Use, Training, and Plant-Specific Knowledge in Manufacturing Establishments*. Ottawa: Statistics Canada, Analytical Studies Branch – Research Document, 1995. No. 11F0019MIF, No. 86.

Baldwin, J., P. Hanel, and D. Sabourin. *Determinants of Innovative Activity in Canadian Manufacturing Firms: The Role of Intellectual Property Rights*. Ottawa: Statistics Canada, Analytical Studies Branch – Research Document, 2000. No. 11F0019MIF, No. 122.

Baldwin, J., and Z. Lin. *Impediments to Advanced Technology Adoption for Canadian Manufacturers*. Ottawa: Statistics Canada, Analytical Studies Branch – Research Document, 2001. No. 11F0019MIF, No. 173.

Baldwin, J., J. P. Maynard, D. Sabourin, and D. Zietsma. *Differences in Interprovincial Productivity Levels*. Ottawa: Statistics Canada, Analytical Studies Branch – Research Document, 2001. No. 11F0019MIF, No. 180.

Baldwin, J., E. Rama, and D. Sabourin. *Growth of Advanced Technology Use in Canadian Manufacturing During the 1990s*. Ottawa: Statistics Canada, Analytical Studies Branch – Research Document, 1999. No. 11F0019MIF, No. 105.

Baldwin, J., D. Sabourin, and M. Rafiquzzaman, *Benefits and Problems Associated with Technology Adoption in Canadian Manufacturing.* Ottawa: Statistics Canada, 1996. No. 88-514-XPF.

Barro, R., and X. Sala-i-Martin. "Technological Diffusion, Convergence, and Growth." *Journal of Economic Growth* 2 (1) (2001).

Bassanini, A., S. Scarpetta, and I. Visco. *Knowledge, Technology, and Economic Growth: Recent Evidence from OECD Countries.* Paris: OECD, 2001. Economics Department Working Paper no. 259.

Basu, S., J. Fernald, and M. Shapiro. *Productivity Growth in the 1990s: Technology, Utilization, or Adjustment?* Cambridge, MA: National Bureau of Economic Research, 2001. Working Paper 8359.

Beaudin, M., and S. Breau, *Employment, Skills, and the Knowledge Economy in Atlantic Canada.* Moncton: Canadian Institute for Research on Regional Development, 2001.

Beaudry, P., and D. Green. *The Changing Structure of Wages in the US and Germany: What Explains the Differences?* Cambridge, MA: National Bureau of Economic Research, 2000. Working Paper 7697.

———. *Population Growth, Technological Adoption, and Economic Outcomes: A Theory of Cross-Country Differences for the Information Era.* Cambridge, MA: National Bureau of Economic Research, 2001. Working Paper 8149.

———. *What Is Driving US and Canadian Wages: Exogenous Technical Change or Endogenous Choice of Technique?* Cambridge, MA: National Bureau of Economic Research, 1998. Working Paper 6853.

Beccatini, G. "The Marshallian District As a Socio-Economic Notion." In *Industrial Districts As Inter-Firms Co-operation in Italy*, edited by F. Pyke, G. Beccatini, and W. Senbengerber, 1990: 37–51.

———, ed. *Mercato e forze locali: il distretto industriale.* Bologna: Il Mulino, 1987.

Becker, G. *Human Capital.* 3d ed. Chicago: University of Chicago Press, 1993.

———. *Human Capital and Poverty Alleviation.* Washington: World Bank Human Capital Development and Operations, 1994. Policy Working Paper.

Bekar, C., and R. Lipsey. "Clusters and Economic Policy." *Canadian Journal of Policy Research* 3 (1) (Spring 2002).

Bellandi, M. *The Marshallian Industrial District*. Scienze economiche, Universita degli studi di Firenze, 1986. Studie discussioni 42.

Bennett, R. J. "Business Associations: Their Potential Contribution to Government Policy and the Growth of Small- and Medium-Sized Enterprises." *Environment and Planning C: Government and Policy* 17 (5) (1999): 593–608.

Berman, E., J. Bound, and S. Machin. "Implications of Skill-Biased Technological Change: International Evidence." *Quarterly Journal of Economics* 113 (4) (1998): 1245–80.

Bernanke, B., and R. Gurkaynak. *Is Growth Exogenous? Taking Mankiw, Romer, and Weil Seriously*. Cambridge, MA: National Bureau of Economic Research, 2001. Working Paper 8365.

Bils, M., and P. Klenow. *Quantifying Quality Growth*. Cambridge, MA: National Bureau of Economic Research, 2000. Working Paper 7695.

Black, D., and V. Henderson. "A Theory of Urban Growth." *Journal of Political Economy* 10 (7) (1999): 252–84.

Blinder, A. *The Internet and the New Economy*. Washington: *The Brookings Institution*, 2000. Policy Brief no. 60.

Blomstrom, M., and F. Sjoholm. "Technology Transfer and Spillovers: Does Local Participation with Multinationals Matter?" *European Economic Review* 43 (4–6) (1999): 915–23.

Boddy, M. "Technology, Innovation, and Regional Economic Development in the State of Victoria." *Environment and Planning C: Government and Policy* 18 (3) (2000): 301–19.

Borensztein, E., J. De Gregorio, and J. Lee, *How Does Foreign Direct Investment Affect Economic Growth?* Cambridge, MA: National Bureau of Economic Research, 1995. Working Paper 5057.

Boskin, M., and L. Lau. *Generalized Solow-Neutral Technical Progress and Postwar Economic Growth*. Cambridge, MA: National Bureau of Economic Research, 2000. Working Paper 8023.

Branstetter, L. *Is Foreign Direct Investment a Channel of Knowledge Spillovers? Evidence from Japan's FDI in the United States*. Cambridge, MA: National Bureau of Economic Research, 2000. Working Paper 8015.

Breau, S. *Profile and Prospects of the Biopharmaceutical Industry in Atlantic Canada*. Moncton: Canadian Institute for Research on Regional Development, 2001.

Britton, J. "Reconsidering Innovation Policy for Small- and Medium-Sized Enterprises: The Canadian Case." *Environment and Planning C: Government and Policy* 9 (1991): 189–206.

Brusco, S. "The Emilian Model: Productive Decentralization and Social Integration." *Cambridge Journal of Economics* 6 (1982): 167–84.

Canada. *Achieving Excellence: Investing in People, Knowledge, and Opportunity. Canada's Innovation Strategy*. Ottawa: Industry Canada, 2002. C2-596/2001F-IN2.

———. *Knowledge Matters: Skills and Learning for Canadians*. Ottawa, 2002.

———. *Science and Technology for a New Century: A Federal Strategy*. Ottawa, 1996.

———. Department of Finance. *Building the Future for Canadians: Budget 1997 – Canada Foundation for Innovation*. www.fin.gc.ca/budget97/innov/innove.pdf

———. Industry Canada. *Trans-Forum*. http://strategis.ic.gc.ca/SSGF/tf00008e.html

———. National Research Council of Canada. *Federal Partners in Technology Transfer*. http://scitech.gc.ca/fptt/aboute.html

———. Statistics Canada. *Estimates of Canadian Research and Development Expenditures (GERD): Canada, 1989 to 2000, and by Province, 1989 to 1998*. Ottawa: Statistics Canada, Science, Innovation and Electronic Information Division, 2001. Working Papers no. 88F0006XIB, no. 1.

———. *Historical Labour Force Statistics, 2000*. Ottawa: Department of Industry, 2001. No. 71-201-XPB.

———. *Industrial Research and Development: Intentions 2000*. Ottawa: Statistics Canada, 2001. No. 88-202-XIB.

———. *Innovation Analysis Bulletin*. Ottawa: Statistics Canada, 3 (3), (October 2001).

———. *Manufacturing Industries of Canada: Subprovincial Areas, 1998*. Ottawa: Department of Industry, 2001. No. 31-203-XPB.

———. *Provincial Gross Domestic Product by Industry: 1984–1999.* Ottawa: Statistics Canada, 2000. No. 15-203-XIB.

———. *Workplace and Employee Survey* Compendium. Ottawa: Department of Industry, 2001. No. 71-585-XIF.

Caselli, F., and J. W. Coleman. *Cross-Country Technology Diffusion: The Case of Computers.* Cambridge, MA: National Bureau of Economic Research, 2001. Working Paper 8130.

Christensen, C. "The Rules of Innovation." *Technology Review* (Cambridge, MA, June 2002).

Clarke, G. *How the Quality of Institutions Affects Technological Deepening in Developing Countries.* Washington, World Bank, 2001. Working Paper 2603.

Cohen, W. M., and D. Levinthal. "Absorptive Capacity: A New Perspective on Learning Innovation." *Administrative Science Quarterly* 35 (1) (1990).

Conference Board of Canada. *Building the Future: 1st Annual Innovation Report.* Ottawa, 1999.

———. *Collaborating for Innovation: 2nd Annual Innovation Report.* Ottawa, 2000.

———. *Performance and Potential, 2000–2001: Key Findings.* Ottawa, 2000.

Cornford, A. *Innovation and Commercialization in Atlantic Canada.* Moncton: Atlantic Canada Opportunities Agency, 2002.

Costa, D., and M. Kahn. *Power Couples: Changes in the Locational Choice of the College Educated, 1940–1990.* Cambridge, MA: National Bureau of Economic Research, 1997. Working Paper 7109.

Darby, M., and L. Zucker. *Local Academic Science Driving Organizational Change: The Adoption of Biotechnology by Japanese Firms.* Cambridge, MA: National Bureau of Economic Research, 1999. Working Paper 7248.

David, P. "Clio and the Economics of QWERTY." *American Economic Review* 75 (2) (1985): 332–37.

———. "Digital Technology and the Productivity Paradox: After Ten Years, What Has Been Learned?" In *Understanding the Digital Economy: Data, Tools, and Research.* Washington, DC: U.S. Department of Commerce, 1999.

David, P., B. Hall, and A. Toole. "Is Public R & D a Complement or Substitute for Private R & D? A Review of the Econometric Evidence." *Research Policy* 29 (2000).

Easterly, W., and R. Levine. "What Have We Learned from a Decade of Empirical Research on Growth? It's Not Factor Accumulation: Stylized Facts and Growth Models." *World Bank Economic Review* 15 (2) (2001): 177–219.

Eaton, J., and S. Kortum. "Engines of Growth: Domestic and Foreign Sources of Innovation." *Japan and the World Economy* 9 (2) (1996): 235–59.

———. "Trade in Ideas: Patenting and Productivity in the OECD." *Journal of International Economics* 40 (3/4) (1996): 251–78.

Edquist, C. *Systems of Innovation: Technologies, Institutions, and Organizations*. London: Pinter, 1997.

Florida, R. *The Rise of the Creative Class*. New York: Basic Books, 2002.

Fujita, M., P. Krugman, and A. Venables. *The Spatial Economy: Cities, Regions, and International Trade*. Cambridge, MA: MIT Press, 1999.

Gans, J., D. Hsu, and S. Stern. *When Does Start-up Innovation Spur the Gale of Creative Destruction?* Cambridge, MA: National Bureau of Economic Research, 2000. Working Paper 7851.

Gingras, Y., and R. Roy, "Genuine Labour Shortage or Cyclical Phenomenon? *Human Resources Development Canada Applied Research Bulletin* 5(1) (Summer 1999).

Glaeser, E. "Learning in Cities." *Journal of Urban Economics* 46 (2) (1999): 254–77.

Glaeser, E., D. Laibson, and B. Sacerdote. *The Economic Approach to Social Capital*. Cambridge, MA: National Bureau of Economic Research, 2000. Working Paper 7728.

Goddard, J. B., and P. Chatterton. "Regional Development Agencies and the Knowledge Economy: Harnessing the Potential of Universities." *Environment and Planning C: Government and Policy* 17 (6) (1999): 685–99.

Goolsbee, A. "Does Government R & D Policy Mainly Benefit Scientists and Engineers?" *American Economic Review* 88 (2) (1998): 298–302.

Gordon, R., *Does the "New Economy" Measure Up to the Great Inventions of the Past?* Cambridge, MA: National Bureau of Economic Research, 2001. Working Paper 7833.

Hall, B., and J. Van Reenen. "How Effective Are Fiscal Incentives for R & D? A New Review of the Evidence." *Research Policy* 29 (2000).

Hall, R., and C. Jones. "Why Do Some Countries Produce So Much More Output per Worker Than Others?" *Quarterly Journal of Economics* 114 (1) (1999): 83–116.

Hanson, G. *Scale Economies and the Geographic Concentration of Industry*. Cambridge, MA: National Bureau of Economic Research, 2000. Working Paper 8013.

Hassink, R., and A. Lagendijk. "The Dilemmas of Interregional Institutional Learning." *Environment and Planning C: Government and Policy* 19 (1) (2001): 65–84.

Henderson, V. *The Effects of Urban Concentration on Economic Growth*. Cambridge, MA: National Bureau of Economic Research, 2000. Working Paper 7503.

———. *Marshall's Economies*. Cambridge, MA: National Bureau of Economic Research, 1999. Working Paper 7358.

Holbrook, J. A., and D. Wolfe. "Innovation Studies in a Regional Perspective." In *Innovation, Institutions, and Territory*, Holbrook and Wolfe. Montreal: McGill-Queen's University Press, 2000.

Hu, A., and A. Jaffe. *Patent Citations and International Knowledge Flows: The Cases of Korea and Taiwan*. Cambridge, MA: National Bureau of Economic Research, 2001. Working Paper 8528.

Hulten, C. *Total Factor Productivity: A Short Biography*. Cambridge, MA: National Bureau of Economic Research, 2000. Working Paper 7471.

Izushi, H., and D. Henderson. "Designing Learning Networks in Peripheral Regions: Comparison of Two Models." *Environment and Planning C: Government and Policy* 18 (6) (2000): 697–710.

Jaffe, A. "The US Patent System in Transition: Policy Innovation and the Innovation Process." *Research Policy* 29 (4/5) (2000): 531–57.

Jaffe, A., M. Fogarty, and B. Banks. "Evidence from Patents and Patent Citations on the Impact of NASA and Other Federal Labs on Commercial Innovation." *Journal of Industrial Economics* 46 (2) (1998): 183–206.

Jones, C., and J. Williams. "Too Much of a Good Thing? The Economics of Investment in R & D." *Journal of Economic Growth* (2000).

Jovanovic, B. "Vintage Capital and Inequality." *Review of Economic Dynamics* 1 (2) (1998): 497–530.

Jovanovic, B., and P. Rousseau. *Vintage Organization Capital*. Cambridge, MA: National Bureau of Economic Research, 2001. Working Paper 8166.

Kearns, A., and F. Ruane. "The Tangible Contribution of R & D–Spending Foreign-Owned Plants to a Host Region: A Plant Level Study of the Irish Manufacturing Sector (1980–1996)." *Research Policy* 30 (2) (2001): 227–44.

Keller, W. "Do Trade Patterns and Technology Flows Affect Productivity Growth?" *World Bank Economic Review* 14 (20) (2000).

———. *Geographic Localization of International Technology Diffusion*. Cambridge, MA: National Bureau of Economic Research, 2000. Working Paper 7509.

———. *The Geography and Channels of Diffusion at the World's Technology Frontier*. Cambridge, MA: National Bureau of Economic Research, 2001. Working Paper 8150.

Krugman, P. *Development, Geography, and Economic Theory*. Cambridge: MIT Press, 1995.

———. *Geography and Trade*. Cambridge: MIT Press, 1991.

———. "The Myth of Asia's Miracle." *Foreign Affairs* (November–December 1994).

———. "White Collars Turn Blue." *New York Times Magazine* (29 September 1996).

Lanjouw, J., and M. Schankerman. *The Quality of Ideas: Measuring Innovation with Multiple Indicators*. Cambridge, MA: National Bureau of Economic Research, 1999. Working Paper 7345.

Leamer, E. E., and M. Storper. "The Economic Geography of the Internet Age." *Journal of International Business Studies* 32 (4) (2001): 641–65.

Leiponen, A. *Essays in the Economics of Knowledge: Innovation, Collaboration, and Organizational Complementarities*. Helsinki: Helsinki School of Economics and Business Administration, 2000.

Love, J., and S. Roper. "Location and Network Effects on Innovation Success: Evidence for UK, German, and Irish Manufacturing Plants." *Research Policy* 30 (4) (2001): 643–61.

Lundvall, B., ed. *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning*. London: Pinter, 1992.

Macdonald & Associates. www.canadavc.com/industrystats.asp?cat=venturecap&year=&quarter=4

McKinsey Global Institute. *Productivity in the United States*. October 2001.

McMillan, C. *Focusing on the Future: The New Atlantic Revolution*. Halifax: Council of Atlantic Premiers, 2001.

Manzano, O., and R. Rigobon. *Resource Curse or Debt Overhang?* Cambridge, MA: National Bureau of Economic Research, 2001. Working Paper 8390.

Moen, J. *Is Mobility of Technical Personnel a Source of R & D Spillovers?* Cambridge, MA: National Bureau of Economic Research, 2000. Working Paper 7834.

Mohnen, P., and P. Therrien. *How Innovative Are Canadian Firms Compared to Some European Firms? A Comparative Look at Survey of Innovations*. MERIT, Maastricht [Holland]: Infonomics Research Memorandum Series, 2001.

Murphy, K., C. Riddell, and P. Romer. "Wages, Skills, and Technology in the United States and Canada." In *General Purpose Technologies and Economic Growth*, edited by E. Helpman. Cambridge, MA: MIT Press, 1998.

Nelson, R. *National Innovation Systems: A Comparative Analysis*. Oxford: Oxford University Press, 1993.

Nelson, R., and S. Winter. *An Evolutionary Theory of Economic Change*. Cambridge: Harvard University Press, 1982.

New Brunswick. *Greater Opportunity: New Brunswick's Prosperity Plan, 2002–2012*. Fredericton, 2002.

Nordhaus, W. *Productivity Growth and the New Economy*. Cambridge, MA: National Bureau of Economic Research, 2001. Working Paper 8096.

Nova Scotia. *Opportunities for Prosperity*. Halifax, 2000.

Oliner, S., and D. Sichel. *The Resurgence of Growth in the Late 1990s: Is Information Technology the Story?* Federal Reserve Board, May 2000. Working Paper.

Organisation for Economic Co-operation and Development (OECD). *The Measurement of Scientific and Technical Activities: Proposed Standard Practice for Surveys of Research and Experimental Development (Frascati Manual)*. Paris: OECD, 1993.

———. *The Measurement of Scientific and Technological Activities: Proposed Guidelines for Collecting and Interpreting Technological Innovation Data (Oslo Manual)*. Paris: OECD, 1996.

———. *A New Economy? The Changing Role of Innovation and Information Technology in Growth*. Paris: OECD, 2000.

———. *Science, Technology, and Industry Outlook, 2000*. Paris: OECD, 2001.

Peng, Y., L. Zucker, and M. Darby. *Chinese Rural Industrial Productivity and Urban Spillovers*. Cambridge, MA: National Bureau of Economic Research, 1997. Working Paper 6202.

Pilat, D., and F. Lee. *Productivity Growth in ICT-Producing and ICT-Using Industries: A Source of Growth Differentials in the OECD?* Paris: OECD, 2001. STI Working Papers.

Piore, M. J., and C. F. Sabel. *The Second Industrial Divide*. New York: Basic Books, 1984.

Pohjola, M., ed. *Information Technology, Productivity, and Economic Growth: International Evidence*. Oxford: Oxford University Press, 2001.

Polanyi, M. *The Tacit Dimension*. Garden City, N.Y.: Doubleday, 1966.

Porter, M. *The Competitive Advantage of Nations*. New York: Free Press, 1990.

Porter, M., and S. Stern. *Measuring the "Ideas" Production Function: Evidence from International Patent Output*. Cambridge, MA: National Bureau of Economic Research, 2000. Working Paper 7891.

Prusak, L., ed. *Knowledge in Organizations*. Boston: Butterworth-Heinemann, 1997.

Putnam, R. *Making Democracy Work: Civic Traditions in Modern Italy*. Princeton: Princeton University Press, 1993.

Riding, A., and B. Orser. *Beyond the Bank: Creating Financing for Canadian Small Business Owners*. Toronto: Wiley, 1997.

Rodrik, D. "Trading in Illusions." *Foreign Policy* 123 (2001): 55–62.

Romer, P. "Endogenous Technological Change." *Journal of Political Economy* 98 (1990): S71–S102.

———. "Increasing Returns and Long Run Growth." *Journal of Political Economy* 94 (5) (1986): 1002–37.

———. "The Origins of Endogenous Growth." *Journal of Economic Perspectives* 8 (1994): 3–22.

———. *Should the Government Subsidize Supply and Demand in the Market for Scientists and Engineers?* Cambridge, MA: National Bureau of Economic Research, 2000. Working Paper 7723.

Rosenberg, N. *Inside the Black Box: Technology and Economics*. Cambridge: Cambridge University Press, 1986.

Rosenbloom, R., and W. Abernathy. "The Climate for Innovation in Industry: The Role of Management Attitudes and Practices in Consumer Electronics." *Research Policy* 11 (1982): 209–25.

Sabourin, D., and D. Beckstead. *Technology Adoption in Canadian Manufacturing*. Ottawa: Statistics Canada, Science, Innovation and Electronic Information Division – Working Papers, 1999. No. 88F0006XPB, No. 5.

Sachs, J., and A. Warner. *Natural Resource Abundance and Economic Growth*. Cambridge, MA: Harvard Institute for International Development, 1995. Development Discussion Paper no. 517a.

Saxenian, A. *Regional Advantage: Culture and Competition in Silicon Valley and Route 128*. Cambridge: Harvard University Press, 1994.

Schaan, S., and F. Anderson. *Innovation in Canadian Manufacturing: Provincial Estimates*. Ottawa: Statistics Canada, Science, Innovation and Electronic Information Division – Working Papers, 2001. No. 88F0006XIF, No. 13.

Schrage, M. "Mimetic Management." *Technology Review* (June 2002): 20.

———. "Wal-Mart Trumps Moore's Law." *Technology Review* (March 2002).

Scott, A. *Technopolis*. Berkeley: University of California Press, 1993.

Siegel, D., D. Waldman, and A. Link. *Assessing the Impact of Organizational Practices on the Productivity of University Technology Transfer Offices: An Explanatory Study*. Cambridge, MA: National Bureau of Economic Research, 1999. Working Paper 7256.

Skelly, M. *The Role of Canadian Municipalities in Economic Development*. Intergovernmental Committee of Urban and Regional Research, 1995.

Smallborne, D., and D. North. "Innovation and New Technology in Rural Small- and Medium-Sized Enterprises: Some Policy Issues." *Environment and Planning C: Government and Policy* 17 (5) (1999): 549–66.

Soja, E. *Postmetropolis*. Oxford: Blackwell, 2000.

Steiner, M. "Clusters and Regional Specialisation: On Geography, Technology, and Networks." *European Research in Regional Science* 8 (1998).

Stern, S., M. Porter, and J. Furman. *The Determinants of National Innovative Capacity*. Cambridge, MA: National Bureau of Economic Research, 2000. Working Paper 7876.

Storper, M. *The Regional World*. New York: The Guildford Press, 1997.

Storper, M., and A. Venables. *Buzz: The Economic Force of the City*. International Seminar on Economy and Space. Faculty of Economics, Federal University of Minas Gerais (FACE/UFMG), Ouro Preto, Minas Gerais, Brazil, 6–7 December 2001.

Sulzenko, A. "Technology and Innovation Policy for the Knowledge-Based Economy: The Changing View in Canada." *STI Review* 22 (1998): 285–305.

Trajtenberg, M. *Is Canada Missing the "Technology Boat"? Evidence from Patent Data*. Ottawa: Industry Canada, 2000. No. 9 (Cat. No. C21-25/9-1999).

———. *R & D Policy in Israel: An Overview and Reassessment*. Cambridge, MA: National Bureau of Economic Research, 2000. Working Paper 7930.

Triplett, J. *The Solow Productivity Paradox: What Computers Do to Productivity?* Washington: The Brookings Institution, 1998.

Wolfe, D. "So Much to Know? Innovation Policy for the Knowledge-Based Economy." In *How Ottawa Spends, 2002–2003*, edited by G. Bruce Doern. Toronto: Oxford University Press, 2002.

Zucker, L., M. Darby, and J. Armstrong. "Intellectual Capital and the Firm: The Technology of Geographically Localized Knowledge Spillovers." *Economic Inquiry* 36 (1998): 65–86.

Sources of Statistical Data Obtained Through Special Orders

Canada. Industry Canada. *Summary Statistical Reports on Patents*. Ottawa: Canadian Intellectual Property Office, 2001.

———. Statistics Canada. *Business Register* (BR). Ottawa, 2001.

———. *Manufacturing Industries of Canada: Subprovincial Areas, 1999*. Ottawa: Statistics Canada, 2002.

———. *1996 Survey of Innovation*. Ottawa: Statistics Canada, 2001.

———. *1999 Survey of Innovation*. Ottawa: Statistics Canada, 2001.

———. *1999 Workplace and Employee Survey*. Ottawa: Statistics Canada, 2001.

Tables

Chapter 4

Appendix

Figures

Chapter 4

Chapter 6